# Think

May/June 1975

## Where do you search?
## What do you search for?

# A REPORT ON THE RESEARCH DIVISION

Page 20

The award depicted on this page is the American Marketing Association's first national Achievement Award, presented to Chairman Frank T. Cary.

## Letter from the Chairman

**What it takes to be first in 'excellence, creativity and leadership . . .'**

IBM was singled out this April by the American Marketing Association for a very special honor: the Association's award—the first it has ever made—for "continuous excellence, creativity and leadership in marketing." I was very happy to accept that award in Chicago on your behalf.

The impetus to IBM marketing leadership began in the early days of our business with the practice of renting equipment and permitting customers to return products to us on 30 days' notice. Those terms and conditions challenged our people to provide the best possible products and service; to keep the customer satisfied not just at the time of delivery or during a limited period of warranty, but continually, so that rental revenues would keep growing.

IBM people responded magnificently to that challenge—not only the talented men and women who add value to IBM products in the field, but also IBMers in research, in development, and in manufacturing. The award is a clear tribute to all of these IBM people who have devoted themselves to understanding customer needs, and then developing productive and profitable uses for IBM equipment in customers' businesses.

In today's particularly challenging environment, it's heartening to receive this confirmation that we have an award-winning team representing us in the marketplace. To all who are part of that team, and to all who support it, I extend my warmest thanks and congratulations.

Frank Cary

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A simple-to-learn programming language is catching on in business.

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# Think

## The contents of this issue, in brief

### THE COMPANY

**How to cut costs** 4

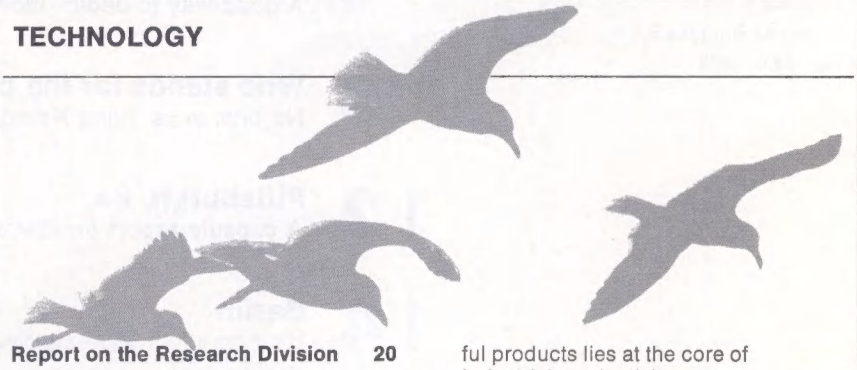
Paper, up 30 percent. Chemicals, up 46 percent. Plastics, up 56 percent. Oil, up 135 percent. Corporations, like people, have been head to head with rising prices for a long time now. The name of the game is learning to cope with the increases—in materials, supplies, services, the wherewithal of day-to-day operations. And keeping profits from dipping even as revenues increase.

IBM is stepping up already substantial efforts to cut costs and increase productivity. Getting special attention are nonproduction items such as furniture, office supplies, and travel. Last year, adding machines and calculators alone cost the company $600,000. The object is to stop the squeeze on profitability and, as Senior Vice President Robert W. Hubner puts it, "create a good business attitude that will continue even when the economy improves and inflation abates."

**Corporate Awards** 36

"A really prodigious confirmation of the talent and human resources at the heart of IBM's success." That's how IBM Vice President and Chief Scientist Dr. Lewis M. Branscomb described this year's Corporate Recognition Banquet. Before it was over, four Corporate Award winners—singled out from the 158 present— shared $90,000 in prize money. Three new IBM Fellows were announced, including the youngest ever named.

### TECHNOLOGY



**Report on the Research Division** 20

IBM's Research Division employs 1,600 people, over 550 of them Ph.D.'s, at laboratories in Yorktown Heights, San Jose, and Zurich. The work they do puzzles, fascinates, and occasionally mystifies—from bubble technology, lasers and electron microscopes, to cryptography, automatic programming, and exploring the limits of computation. But the essence of their undertaking—a delicate blend of basic science and advanced technology—forms the basis for IBM's progress. Indeed, translating new ideas into useful products lies at the core of industrial productivity.

How does the Research Division operate? How does it push existing technologies and pursue alternative technologies at the same time? What underlying philosophy holds this combination academic/industrial world together, and what motivates its people? In a special report, journalist Richard Bode explores the complex dimensions of Research in IBM. A conversation with Ralph Gomory, IBM vice president and director of research, offers a broad perspective on the nature of research.

### ISSUES

**Who stands for the corporation?** 8

The corporation is everybody's favorite target, says author Irving Kristol, and there are lots of reasons for it. The corporation is a relatively new institution, unforeseen by the Founding Fathers. It is also generally misunderstood as simply a larger version of a small enterprise. While other groups can count on their members to defend them, corporations are weak and vulnerable because they lack a constituency. One answer, says Kristol, is to create a constituency from among stockholders, employees, or other groups. It won't be easy, but it may be the best way to assure the corporation's survival.

### THE WORLD

**Sea water into fresh water** 42

For years, hot, dry Sardinia has taken little comfort from the vast sea that surrounds it. The Sards have long been trying to convert salt water into palatable drink. Now, with the help of an IBM computer, they are getting the fresh water the island sorely needs. Near the sleepy coastal town of Porto Torres, one of the largest desalination plants in the world has been constructed, controlled by 10 people and the computer. Not only has the project injected new life into the local economy, but it's become a model for other countries that want to get fresh water from the sea.

## MARKETPLACE

**Newest** 40

It's called 6:5 because IBM's latest dictation unit can record six minutes or up to five hours of what you want to say. That flexibility has made it the Office Products Division's most popular new product. IBM marketing people like to talk about it, and customers—judging by the sales record—like to buy it.

**Things go better with APL** 46

What's 13 years old, has spent most of its time in the classroom, and is fast becoming business management's good friend? Answer: IBM's APL, which stands for *A P*rogramming *L*anguage. Today, this long-acknowledged, terminal-oriented aid to the student of mathematics, economics, and engineering is helping business distribute soft drinks, plan its finances, and produce automobiles. IBM's own use of the language has quadrupled in the past several years. Every IBM division relies on it in some way—to help test systems, design products, plan strategy.

**Berlin** 14

A three-way look at what's happening in IBM Germany, the largest IBM organization outside the United States. First stop: West Berlin, once embattled but now considered a touchstone of East-West détente. IBM's business there traces back to 1910. The newest facility: an Office Products plant specializing not only in exports to 84 countries, but also in some exciting job development innovations. Manufacturing at four German plants accounts for one of every three IBM jobs in the country, bringing business to thousands of German suppliers.

At the head of this company is Walther Boesenberg, president and general manager. Last year, he saw IBM Germany's growth slacken in an uncertain national economy. But, so far this year, the business barometer is rising, and Boesenberg continues to savor the future: "We are only at the beginning."

# Notes

Printers have always had a tough time keeping up with the vast amounts of data generated by computers at electronic speeds. That gap was narrowed in April when the IBM 3800 printing subsystem was announced. It's nearly six times faster than the fastest IBM printer now in use. IBM's first nonimpact printer uses a low-power laser beam to print images on a photoconductive surface similar to that used in some photocopying machines. The machine is so fast—up to 13,360 lines per minute—that, in most applications, it can print multiple originals of the same report faster than an impact printer can make carbon copies. Developed by the General Products Division at its San Jose facility, the 3800 uses plain paper, printing a form design at the same time it prints the characters. Because it uses less paper, reduces the need for pre-printed forms, and eliminates the need for carbon paper and ribbons, the new printer can lower a typical user's total printing cost by as much as 30 percent.

Japan's prestigious Blue Ribbon Medal (Ranju Hosho) has been awarded to Sanae Inagaki, chairman and chief executive officer of IBM Japan. Inagaki received the medal from Prime Minister Takeo Miki in an award ceremony on April 21, followed by an audience at the Imperial Palace the next day. The award is in recognition of Inagaki's many years of contributing to the welfare and prosperity of Japan through the development of the computer industry.

Boys' Clubs of America has presented its highest honor—the Herbert Hoover Memorial Award—to Thomas J. Watson, Jr., chairman of the Executive Committee of IBM's Board of Directors. Watson received the award in May for his decades of "leadership and example" in the service of youth both "in this country and throughout much of the world." A former president of the National Executive Board of the Boy Scouts of America, Watson now sits on the Boy Scouts National Advisory Council and the World Committee. Among others who have received the Boys' Clubs award are Bob Hope, Lyndon B. Johnson, and Dwight D. Eisenhower.

# HOW TO CUT COSTS

## A good way to begin: Don't buy what you don't need

**by Ernie Bauer**

For most people, a 69-cent paperback dictionary will do just as well as a $6.50 hardcover edition. A handcrank pencil sharpener gets the same results as a more fashionable $30 electric model. And ash trays, whether they're $10 apiece or 30 cents, treat ashes equally well.

The same kind of price spread probably exists for most of the hundreds of products and services IBM people need to do their work. Yet purchasing departments are still getting requisitions that specify top-of-the-line items when standard, less costly models would undoubtedly do just as well. That, according to John Brislin, director of purchasing at Corporate Headquarters in Armonk, who keeps a watchful eye on purchasing patterns across the country.

Brislin has compiled a considerable list of such extravagances to demonstrate how everyone can help IBM fight the growing problem of rising costs. "What it comes down to," he says, "is that all of us have got to be much more cost-conscious when we submit a requisition or approve one.

"Purchasing's job," says Brislin, "is to give good service and to buy wisely, and we'll continue to do that. But buying wisely something that isn't *really* needed is the biggest waste of all. We can't make that judgment. But, in times like these, we want to make sure that everyone who signs a requisition has seriously considered that need and the cost and the possibility of less-costly alternatives."

The fact is that costs—everything IBM pays for labor, materials, and supplies to develop, build, sell, and maintain its products and services and to administer the business—are going up steeply. And they are only partly balanced by price increases and productivity improvements.

The trend is shown in IBM's annual report for 1974. Gross income from rentals and services was up 10.1 percent from 1973. But the *cost* of rentals and services went up even steeper—12.7 percent.

Or to compare two other items in that same report: Total gross income for 1974 was up 15.3 percent over 1973. But "selling, development, and engineering, and general and administrative expenses" were up 18.2 percent. And virtually every segment of the business is included within those two cost and expense items.

When costs go up faster than income—as any student of economics knows—earnings are squeezed. Not that IBM is severely afflicted by any such bind. The company continues to be profitable and strong—and, indeed, that's not the point.

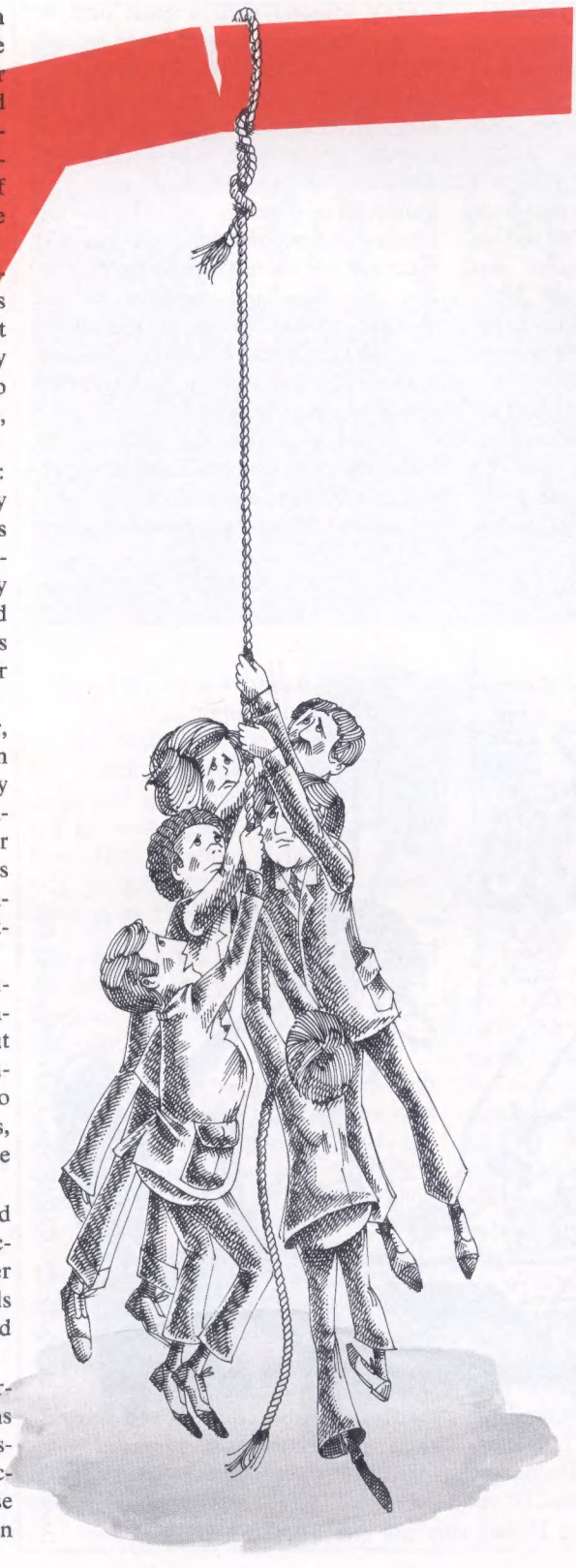
Says Chairman Frank T. Cary: "Given today's economy, the company is performing well. But inflation is causing an erosion of profits that cannot be denied or ignored. Our ability to continue as a growth company and to deserve investor confidence depends a great deal upon maintaining our profitability."

Raising prices is not the answer, although, of necessity, there have been some price increases. For as Cary points out: "Our salesmen are in competition for orders against many other companies. And prospective customers still compare prices just as they compare everything else about the competing products."

Other factors argue against price increases—in many World Trade countries, prices cannot be raised without government approval. And, to an important extent, the company wants to fight inflation by holding down costs, not simply passing them along to the customer.

Another way to fight inflation and hold down costs is to increase productivity—that is, to get more and better results from the labor and materials the company puts into products and projects.

For example, an extensive advertising and direct mail campaign has made it possible for the General Systems Division to "pre-qualify" prospective System/32 customers and increase the productivity of its sales reps. An



# Profits? They're down

## For business, generally, the squeeze is on

For business as a whole, the profit outlook for 1975 has started out badly. A *Wall Street Journal* survey of 644 companies shows a 21 percent decline in profits for the first quarter of 1975 from the year before. And despite an anticipated pickup in business later this year, a spokesman for the Commerce Department foresees a 12 to 15 percent drop in after-tax corporate earnings for 1975. This weakness in profit, he fears, will dent business spending for plant expansion and new equipment.

Much of this decline in profit can be laid to sagging sales. During the last six months, the nation's Gross National Product has slipped 5 percent. But most companies also find themselves pinched by higher costs for labor, materials, services, and supplies. To take one example, the cost of air travel alone rose by 9 percent during the last ten months.

1975 comes on top of a lean 1974 for most companies. Average profits for manufacturing companies last year amounted to a bare 5.2 percent—a far cry from the 33 percent most people cite when asked about the profits of corporations.

Despite IBM's strong showing for 1974, the company is not immune to the pressures on profit that come with higher costs. And since salaries account for about 60 percent of the company's costs, a strenuous effort is being made in all areas of the business to increase productivity as well as to hold down the costs of materials, supplies, and services. The accompanying article, an overview, offers a few tips on how you can help.

early study shows that it took an average of only 2.3 calls and four hours to close sales that resulted from direct mail inquiries.

To insure that no savings possibilities are being overlooked, and to consider a range of ideas for savings that can be applied on a companywide basis, the chairman has established an ad hoc committee consisting of IBM Senior Vice Presidents Robert W. Hubner and Warren C. Hume, and Dean P. Phypers, IBM vice president, corporate finance and planning staffs.

"We think the problem can best be managed by tightening up already established control procedures and by keeping everyone aware that the problem exists," says Hubner. "IBM people usually respond with a great deal of enthusiasm and ingenuity when we ask their help in situations like this.

"We are focusing our attention on those areas where savings can be substantial, yet have little or no negative effect on the business. We aren't, for example, considering any changes to salaries and benefits, even though that accounts for more than 60 percent of the total cost and expense picture. Neither do we intend to reduce or eliminate any programs or expenditures that clearly will end up in improving our products or services.

"In other words, the object is to make the company lean and stronger, not, in any way to slow it down. What we want to do is create a good business climate and attitude that will continue even when the economy improves and when inflation abates."

For committee consideration, the staff of IBM Controller Art Northrop has prepared studies of actual and projected expenditures in several selected expense categories now under scrutiny. Two examples: travel, and moving and living, up 29 percent last year; telecommunications (telephones, data transmission), up 18 percent.

By far the biggest increase, 41 percent, was administrative support, a collection of "little" items—stationery and office supplies, postage, office rearrangements, books, newspapers, subscriptions, administrative meetings. Those items will be getting much more attention.

Says Northrop: "Many of the locations and divisions are, on their own, tightening up their procedures and operations to make sure they are spending only what is necessary. We see encouraging signs that IBM people in all jobs and positions realize how inflation can threaten the strength of our company. They are making serious and effective efforts to cut costs and increase productivity."

*"Our life style went last year. What can we cut out this year?"*

*Drawing by Donald Reilly; © 1974 The New Yorker Magazine, Inc.*

## Price-watchers

1974 was not a very good year when it came to prices.

Take, for example, what happened to the eight basic materials most important to IBM.

Price increases ranged from 135 percent in the cost of oil to a "mere" 22 percent in the cost of copper. The others: aluminum, up 32 percent; chemicals, up 46 percent; paper, up 30 percent; plastics, up 56 percent; PVC (polyvinyl chloride, used extensively as insulation for wire), up 48 percent; and steel (IBM buys 7,000 varieties), up 25 percent.

In its staff function, John Brislin's Corporate purchasing organization keeps a close eye on these prices, and—

with the help of Corporate economists —tries to forecast where they're going.

"Except perhaps for chemicals and paper," says Brislin, "we buy relatively small amounts of these in their 'raw' state. What really makes them important is that they are the key ingredients in many of the parts and supplies that we buy in large volume.

"By plotting them carefully we can do a better job of planning, and, whenever possible, time our buying to our advantage. We do this in a limited way, however, because IBM chooses not to stockpile, or build up inventories, in anticipation of price rises. It's costly, for one thing, and a sudden breakthrough in technology could leave us stuck with a lot of useless parts."

There are about 1,000 IBM buyers around the world doing business with about 70,000 suppliers. The huge and varied shopping list includes more than 600,000 items that have been assigned part numbers and thousands more that have not.

"Many of the things we buy are production parts," says Brislin. "To make a significant saving in that area usually requires an engineering change or redesign of the products in which they're used.

"Nonproduction items offer better opportunity for reduced spending. Right now we're looking at office furniture and adding machines and calculators. For example, we've been spending several million dollars a year on furniture. But it seems logical that with very little new hiring we can get along on a lot less. I think we can easily cut our worldwide furniture buying by two-thirds this year.

"In the United States alone, we spend $600,000 a year on calculators and adding machines; it seems that everybody has to have one. Maybe we can get along on one per department or some such arrangement.

"Anyway, purchasing is going to be pretty hard-nosed on things like that. So if we appear to be unfriendly, forgive us. We're just taking our jobs, and this business, very, very seriously." ■

# SAVINGS

## A few of the countless ways IBM people are cutting costs

The Burlington purchasing department has assigned part numbers to more than 25,000 nonproduction items such as tool room, maintenance and office supplies, and spare parts for manufacturing and test equipment. This makes it possible to develop a data base and to buy in quantity, based on past use. Savings in 1974: $234,000.

The research lab at Yorktown Heights consolidated its payroll with Poughkeepsie. Estimated savings: $50,000 per year.

At Endicott, they've designed and built a high-speed drilling tool that can drill the 12,000 holes required in each circuit card panel in one-fifth the time it used to take. The savings—$170,000 per year.

Endicott has succeeded in substituting palladium where gold was previously used to plate connecting pins on printed circuit boards. With the price of gold what it is, annual savings have been estimated at "several million dollars." They have also cut down copper consumption by changing the printed circuit manufacturing process. No dollar figures yet, but they will be substantial.

Energy conservation programs coordinated by the Real Estate and Construction Division are now in effect at 33 locations. During 1974, total fuel savings came to more than 21 million gallons; electric power, down by 423 million kilowatt hours. Total cost savings: more than $13-million.

Paper prices have skyrocketed, so conservation efforts to save our forests have become major conservers of money. One of the biggest economies has been achieved by the Office Products Division's Boulder plant in testing Copiers. Naturally, Copiers are tested by making copies. Instead of copying meaningless test patterns, they now run actual jobs. When actual jobs are not available, the testers run simple ruled sheets which are then bound into pads for general use.

In Europe, a major project to consolidate computer services has replaced small compute centers with remote terminals. There were 139 processing compute centers in 1973. Now there are 91, and by 1976, there will be 80.

# Who stands for the corporation?

No one, says Irving Kristol. And that's why it's being bullied. What business needs, he says, is a constituency to give it clout in today's conflict of interests and ideas.

**by Irving Kristol**

No one today seems to have a kind word for the large corporation. Journalists regard "big business" as a permanent topic for muckraking, an attitude that, after almost a century, has become an habitual cast of mind. The public, if opinion polls are to be believed, has little confidence in the integrity or credibility of the large corporation—whether this is cause or consequence of the activities of politicians and journalists can probably never be satisfactorily answered.

But if one is to see this criticism in its proper perspective, it is both useful and important to realize that it is not substantially new. It merely *looks* new because we have only recently emerged from two extraordinary decades. They are the years 1945-1965, when the large corporation enjoyed a relatively good reputation—perhaps the best it has ever had. In that period, which came upon the heels of 15 years of depression, war, and general deprivation, the interests of the American people and those of the large corporation meshed very nicely, indeed. People wanted jobs with some promise of security of employment and with fringe benefits (pensions, medical plans, etc.) that only a large corporation could promise. They also wanted homes, automobiles, washing machines—all of the things that "big business" in particular is very efficient at providing. A kind of honeymoon atmosphere developed and criticism was limited to academic and intellectual circles, where it was thought that the large corporation suppressed individuality in favor of the conformity of an "organization man." Since this criticism was irrelevant to the aspirations of the average American for an improvement in his material standard of living—and organization men were neither more nor less common in large corporations than in large universities, or in the governmental civil service—it was largely a literary phenomenon without serious political or social consequences.

In the last ten years, however, a quite traditional hostility to the large corporation has revived—with a vengeance. Yet the corporation during this past decade has not become significantly different, nor has it done things much differently from the two prior decades. Memories are short, of course. The upsurge of the new wave of criticism has led many people—including many corporate executives—to search for novel deficiencies in corporate structure and delinquencies in behavior. In fact, there is nothing extraordinary about this new hostility. What can be seen to have been extraordinary, in retrospect, was the relatively benign view of big business in the immediate post-war years.

To begin with, it is important to realize that the modern large corporation is *an accidental institution.* Neither the theorists of modern capitalism nor the theorists of modern democracy ever anticipated its existence. Adam Smith had nothing to say about it, nor did economic theory as a whole, as this theory developed in the course of the 19th Century. The capitalist was usually envisaged as an individual entrepreneur, or at most as a firm—by which was meant a small family-owned business or a joint-stock company—i.e., a large business association formed for a temporary and specific purpose such as building a canal or a railroad. The common assumption was that the association would dissolve when its purpose was achieved.

Similarly, the *political* theory of democratic capitalism, as construed by the Founding Fathers and subsequent American thinkers, was highly individualistic. It was as-

sumed that individual Americans might form voluntary associations for one end or another. But there was simply no place for such large, permanent, powerful institutions as the modern corporation.

In prosaic economic terms, to be sure, there was nothing accidental about the emergence of the large corporation. It came into existence before the turn of the century—not only in the United States but in all industrializing nations—because developing technologies required huge investments of capital, and also because rapid urbanization created huge markets that could be most efficiently serviced by large-scale organizations. In fact, a modern, affluent, dynamic economy is unthinkable without the large corporation. In this sense, it was *an inevitable institution*. But, though the reality was inevitable, it was a reality not sustained—and, most important, not legitimized—by an idea, a theory, or a political philosophy. Democratic opinion has always been suspicious of large concentrations of private power, seeing in them a possible threat to the sovereignty of the people. And it did not allay this suspicion for the corporation to explain that it was a terribly efficient—indeed an indispensable form of economic organization. No one has ever really doubted the superior efficiency of a corporation as against smaller units of economic enterprise. Even today, no critic of the corporation seriously calls for a return to small-scale business, and to the much lower standard of living that this reformation would entail. What is at issue, however, and what has always been at issue, is not the existence of the corporation but *the legitimacy of its mode of government*.

That this has always been the real issue has never been entirely clear, either to critics or defenders of the corpora-

tion. The political critics of the corporation, wedded to traditional democratic-capitalist ideas, perceived it as some sort of cancerous growth upon the healthy body of individualistic free enterprise. Since radical surgery was clearly impossible, they hoped to contain this unnatural growth and perhaps even diminish it by frequent exposure to radioactive rhetoric, so to say, as well as by the continual injection of regulatory drugs. The defenders of the corporation, on the other hand, kept pointing to its economic efficiency as proof of its being both a natural and healthy development—but these defenders, too, could only envisage the corporation as a version of individualistic free enterprise writ large, so that the question of governance was irrelevant.

What neither the critics nor the defenders would admit, even to themselves, was that they were involved with a new kind of institution, not continuous with the older entrepreneurial institutions and not to be understood in terms of the ideas associated with those older institutions.

What is new about the modern corporation is not merely its size, or the fact that it is governed by the laws of limited liability. What is truly new is its aspiration toward permanence. The modern corporation is not a business in the traditional sense—coming into being to satisfy a demand for some particular goods or services, and dissolving when this demand has been satisfied. The corporation may begin—

**'The prevailing drift of events is adverse to the survival of the large corporation.'**

usually does begin—in this way. But once it exists, it resembles an investment banker as much as it does a business entrepreneur. Its aim is to achieve an acceptable return on the investment of its capital—and the particular business it happens to be in, at any time, is a secondary consideration. This is an oversimplification, of course. Since management, to be successful, must know what it is doing, corporations usually do concentrate their efforts in one area. But the area itself is constantly being redefined.

Occasionally, to be sure, a corporation will die as a result of bankruptcy or merger. All this signifies is that it has failed in its intention toward permanence. But the intention itself is beyond doubt—and is actually institutionalized in its contractual arrangements with its employees (such as the establishing of pension plans). The assumption behind the modern large corporation is that it *never* makes sense, no matter how good or bad business at any moment might be, to dissolve itself and distribute its equity to its shareholders. Indeed, if any large corporation tried to proceed in this way, government and the trade unions would certainly step in to prevent it.

But if the modern corporation is a new kind of economic institution, it still needs a legitimating idea. For many decades, corporate executives were able to ignore this question of legitimacy by arguing that the corporation was simply a variant species of private property protected by all the laws pertaining to free enterprise. And, for many decades, the courts went along at least part way with this reasoning. But, more recently, the courts have been less and less convinced of the cogency of this argument. Politicians, who felt uneasily that their prerogatives of running things were being threatened by these new concentrations of economic power, never did accept the argument. Which leaves the corporate executives of today ideologically defenseless before the question: Granted that the institution of the large corporation is here to stay, why should *you* run it in ways that *you* see fit and proper?

To this crucial question, the usual answer is: "We can do the job most efficiently." But this is not really a satisfactory answer. Not all corporations are run efficiently; very few are run efficiently for a long period of time; and, it is not, in any case, always easy to know with assurance whether or not a corporation is being efficiently managed. For example, a corporation may be making temporary sacrifices for the sake of its eventual prosperity. Or, it may be achieving a temporary prosperity at the expense of its longer-term interests. On a judgmental issue of this kind, even the most reasonable of men are bound to disagree. That is why the argument from the standpoint of efficiency is never a legitimating argument for an institution that aspires to permanence. This holds for governments, universities, or trade unions, as much as for corporations. It is simply impossible to know, most of the time, whether the claim to efficiency is valid or not *in the long run*. That is why institutions that aspire to permanence always seek legitimacy elsewhere.

Nonprofit institutions such as universities, foundations, or organized charities often claim legitimacy in terms of their purpose—i.e., serving the public interest. Whether they do or do not serve the public interest, in any particular case, may be a matter of dispute. But their *bona fides* and their claim to independent existence are legitimated by their nonprofit status. Frequently, the boards of directors of such institutions constitute a kind of self-perpetuating oligarchy; but since they usually serve without pay, it is assumed that their motives are public-spirited rather than reflecting any private interests. And when these institutions do encounter difficulties or opposition, they can usually count on the support of a sector of public opinion that approves of their general purposes.

Most other institutions, however, are validated in a democracy by the political process that shapes their structure of

self-government. This means, in practice, some simulacrum of the representative principle. This is, of course, true for government; it is also true for trade unions and for any professional organization, such as the American Medical Association, which is perceived as serving private interests rather than the public interest. Leaders of these organizations speak for their constituencies, and are given a hearing because they have been elected by their constituencies.

The trouble with the modern corporation is that it is an organization representing private interests but not any clearly defined constituency to whom these interests are attached. This means that, in principle, the legitimacy of corporate government is not taken seriously. It also means that the corporation as an institution is weak and vulnerable in its inevitable conflicts with other constituencies, and above all with government itself.

'...for the corporation to do nothing is to be an accomplice in its demise.'

In theory, the corporation is said to have a number of constituencies. Among them employees, dealers, suppliers, and customers. Presumably, one or another of these groups might be cultivated. But there is one group whose interests fully coincide with management's, and which is, therefore, a natural constituency. That group is the stockholders who, by law, are the rightful owners of the corporation.

In practice, however, stockholders seldom consider themselves as citizens or members of the institution in which they invest. More often, their attachment to the corporation is loose and irregular. They pay little attention to matters in which the corporation becomes involved. And, if they are unhappy, most stockholders will simply "vote with their feet"—i.e., sell their stock.

This lack of interest and of commitment tends to give management a relatively free hand. But it also leaves the corporation an utterly defenseless institution—an organized interest without an organized constituency. Politicians (and others) then feel free to harass it, attack it, or disregard it—all with impunity. And, if something can be done with impunity, there is generally an irresistible temptation to do it.

Does this mean, then, that the corporation is literally up the creek without a paddle, alienated and friendless, at a time when it desperately needs friends to stand by it and speak for it in the corridors of power?

It does—if corporations go on ignoring their need for a constituency and failing to make the strenuous effort required to cultivate one. The fact that stockholders do not now identify with the long-term interests of the corporation might be remedied, in part, by legal changes which would reward them for being long-term investors, even though one can argue the pros and cons of such a move and its possible effects on the securities markets.

Once created, a stockholder constituency would also need to be led. And this would require a shift in the attitude of corporate management, which has traditionally devoted its primary energies to running the organization while giving lesser attention to public leadership.

Not until the corporation takes some greater initiative will it be able to create a constituency that can intervene—credibly and with effect—when the corporation is subjected to arbitrary governmental action, whether it be in antitrust, rate regulation, environmental controls, or whatever.

Such intervention is now established as proper and normal; there is not going to be any return to free enterprise as usual. But arbitrary and senseless intervention is never proper or normal, and may be duly protested and fought against. In such a contest, however, one needs what the politicians call "muscle." And, at the moment, the corporation is the essence of flabbiness—which is why it is picked on and bullied so easily. Only a constituency can give it the moral and political strength to take part in the eternal conflict of interests and ideas that are at the heart of the American democratic process.

Not that the stockholder constituency is the only possible solution to this problem—or even that it is, of certainty, any kind of solution at all. There are corporate executives who very much incline toward the latter view, and, indeed, they may be right. But there is no way of knowing if a stockholder constituency would work unless it's given a fair chance. There may also be other strategies. It may be possible for some corporations, for example, to cultivate an employee constituency, especially in situations where a large number of employees view their interests as being in concert with those of the corporation. Failing alliances of this kind, there may be no strategies at all capable of coping with this traditional animus toward business. What is beyond question, however, is that the prevailing drift of opinion and events is adverse to the survival of the large corporation in its present form and, hence, to the private sector in its present form. However difficult the task of creating some supportive constituency, for the corporation to do nothing under these circumstances is for it to be an accomplice in its own demise. ■

*Irving Kristol, Henry R. Luce Professor of Urban Values at New York University, is a respected critic of American institutions. He is a member of* The Wall Street Journal*'s board of contributors and has written numerous articles and books, including* On the Democratic Idea in America. *He serves as co-editor of* The Public Interest *magazine.*

# All in the family

How does it feel to be fourth in line in order to be first?

"Pretty good," says David L. Kleiber, 18, the fourth member of his family to receive a Thomas J. Watson Memorial Scholarship—a first in IBM history. "I had my bags packed in case I didn't get it," he says jokingly. "But I figured I *should* be able to do as well as my brothers." His predecessors: Martin in 1970, Robert in 1972, and Gregory in 1974.

The six-foot redhead is the son of Arnold J. (Jim) Kleiber, a senior market advisor in litigation analysis, and his wife, Margaret, who have six boys and two girls and live in Stamford, Conn.

David plans to follow his brother, Robert, 19, to Michigan State University, but his career interests are different—not business or pre-law, but conservation. He'll major in fisheries and wildlife. He likes the land and wants to help preserve it. As he puts it: "You can't create a man-made wilderness." Recently, as part of a high school mini-course, he and a friend explored the flora and fauna on Cape Cod, and wrote a thesis on their findings.

Fourth in his class of 164 at Fairfield College Prep School, David was the star goalie on the varsity ice hockey team, and served for two years as a student council member. He also teaches religion to youngsters in his parish, keeps his '67 Dodge in shape for his 50-mile round trip to school, and, as his brothers before him, caddies to keep himself in spending money, and provide savings for college.

According to his father, Dave is the quietest of the older children: "I guess he figured he might as well listen because everyone else was talking at once—especially at dinner. From early on, that was the one time we could all be together. It's given us a chance to exchange ideas. As a family, we feel this is important since each one of us has separate interests.

"Marty [22, now on a graduate fellowship at Rice University] set the example for the rest of the kids in study habits—homework first, then play, and it's filtered down." David adds: "When you saw him, Bob, and Greg [18, a Haverford freshman] studying all the time, you studied, too. And we never wanted to bring home bad papers that had to be signed, so we practiced getting good ones."

Jim Kleiber says that, while the children have natural talents, they're also excellent test-takers, "which can make a lot of difference. But their real goal is to make their mother and me happy, and we certainly are that." ■

PITTS

# BURGH, PA.

*Above: Chairman Frank T. Cary shows stockholders Priscilla and Donald T. Durlak (an advisory marketing rep with Pittsburgh Manufacturing and Distribution) and Mrs. Cary some features of the new 6:5 Cartridge System.*

*One of the most popular displays at the annual meeting demonstrated how System/4 Pi will be used on space shuttle flights.*

What the Allegheny and Monongahela Rivers have been doing for umpteen million years, IBM stockholders did for the first time this April. They met in Pittsburgh.

The three-hour-and-eight-minute annual meeting—longest in the company's history—was marked by a calm, business-like discussion of IBM's performance during the current economic downturn and by a long polite exchange of opinions on IBM's activities in South Africa and Chile.

Chairman Frank T. Cary called the meeting to order promptly at 10 a.m. More than 1,250 stockholders filled the orchestra and part of the grand balcony of the elegant Heinz Hall for the Performing Arts near Pittsburgh's famed Golden Triangle.

Cary discussed the effects of inflation and recession. "I can assure you," he said, "that we have no intention of waiting for conditions to improve. We're helping our customers identify additional opportunities to improve productivity by using IBM equipment. We're improving the management of our assets and we're investing in the future through our research and development.

". . . There has never been a time when the technologies that are important to our business have been moving more rapidly or when there have been more exciting things in our laboratories."

Cary cautioned stockholders that, with the Justice Department's suit against IBM about to go to trial, they would be hearing and reading accusations against the company. "The plaintiff presents his case first," he said, "but we will also have our day in court." Although, by court order, he could not discuss the case in detail, Cary said again that he was convinced that IBM's business practices have been ethical and its legal position sound.

IBM's role as an international enterprise and the possible threat of some proposed tax legislation now under Congressional study was addressed in some detail by the chairman. "We believe," he emphasized, "that most nations benefit from IBM's international activities. They benefit from the jobs we create and the products we provide. And both the United States and the other countries benefit from the taxes that we pay." He called on stockholders, as concerned citizens, to speak up in support of fair taxation that will keep American companies competitive in world markets.

Almost an hour of the meeting was devoted to a discussion of a stockholder proposal—by a coalition of 14 churches and church groups—calling on IBM to cease doing any business with the government of South Africa. It was the third year in a row that opponents of that nation's apartheid policy had submitted similar proposals.

Cary repeated IBM's stand against racial discrimination of any type. He went on to say: "I think [the proponents of the resolution] are very, very sincere in believing that the way to change things is for IBM to withdraw from South Africa. We may be naïve, but IBM believes that we should stay and set a good example and be a positive force in that society for constructive change."

In subsequent balloting, the proposal was defeated, as were two other stockholder proposals, one dealing with political contributions and the other with cumulative voting for directors. In other business, the stockholders—more than 83 percent of the outstanding shares were represented in person or by proxy—reelected 23 members of the board and ratified the appointment of auditors.

Many stockholders visited an exhibit area with new IBM products on display. Among them: System/32, the 6:5 Cartridge System for dictation *(see page 40)*, the supermarket system, and System/4 Pi (the IBM areospace computer that will process information aboard the upcoming space shuttle flights). ■

STORE

# Berlin

"A venturesome race of men," Germany's great poet Goethe called Berliners some 175 years ago. Nothing has changed. The city's commercial and artistic life still beats with a special pulse, and IBM Germany, by its business presence, contributes to the tempo.

West Berlin, a once beleaguered island in the Eastern Zone, is approximately 110 miles from West Germany. Its links are air corridors, waterways, highways, and railway lines. It is a metropolis of more than 2 million people and 3,000 industrial firms—yet gracious enough to give over one-fifth of its total area to the open space of woods, lakes, and rivers.

IBM has been here since 1910, through the tumult of two World Wars, into the promising industrial era of today. Its profile on the Berlin business skyline is outlined by a branch office, a card plant, and an Office Products plant. A total of 1,500 IBM people work in the city.

The decision to build the new OP plant was spurred three years ago when the four Allied Powers, who administer Berlin's special status, agreed to guarantee continued free access to the West. The contrast with 1960 is startling. In that bleak year, shortly before the 28-mile-long Berlin Wall was built, IBM began a new branch office on Ernst Reuter Platz as a conscious gesture of American commitment.

To dramatize the gesture, the late A. K. Watson, then president of the IBM World Trade Corporation, and West Berlin Mayor Willy Brandt sat together in an excavator to break ground at the site. At a press conference, Watson observed that "the first thought of building a new office building here in Berlin came to me more from my heart than from my head, because for many years I have had the opportunity of coming here and seeing the Berliners and what they can accomplish. I believe that as Berlin goes, so goes Western Europe."

And Willy Brandt added with simple eloquence: "This is a happy and remarkable day."

In the years since, Berlin has known many such days as it has taken on its current status as "a touchstone of détente." Businessmen from Soviet Bloc countries may now visit for 31 days without a visa or residence permit. And the pace of commercial expansion and construction is unflagging.

IBM's new Office Products plant is a case in point. The plant is the only one outside the United States producing IBM dictation equipment. It also manufactures typebar typewriters and the Copier. Finished products leave for

**In 1623, Wilhelm Schickard** of Tubingen, a university town about 30 kilometres away from Sindelfingen in southern Germany, wrote to the noted astronomer and mathematician, Johannes Kepler, describing a machine capable of multiplying two numbers and carrying digits to the next highest column. He called it a "mechanical clock," but some people say it was the first digital computer.

Today, if Schickard could make the short trip from Tubingen to a forest halfway between Sindelfingen and downtown Stuttgart, he would find the experience hard to believe. For in that forest is the headquarters of a company known as IBM Germany. It is the largest IBM company outside the U.S. —and the leading IBM manufacturing organization outside the U.S.

Four of the 13 DP and OP plants in Europe are located in Germany; and one of every three German IBM employees works in manufacturing.

In 1974, IBM Germany's plants exported products valued at over $500-million. Approximately 60 percent of subassemblies, components, and materials that go into those products is purchased from 6,000 companies, most of which are German.

The largest plant, Sindelfingen, with close to 3,800 employees, manufactures memory products for IBM in Europe, the Middle East, and Africa. It also ships memory components to countries in IBM's Americas/Far East Corporation and shares with the Essonnes plant in France a mission to furnish logic components.

The smaller and newer Hannover plant builds memory subassemblies and power supplies. It has 800 employees.

While Sindelfingen and Hannover are considered "technology plants," the third DP manufacturing site, Mainz, is known as a "box plant" because it produces units such as disk files and the central processing unit for System/370 Model 145.

The Berlin plant is one of three European OP plants; the others are in Amsterdam, and Boigny, France.

84 countries, and many of them are tailored to the special needs of those markets.

The Berlin OP plant has gained an almost overnight reputation for innovation. "What we did," explains Karl-Ernst Beilharz, personnel manager, "was introduce job development in the areas of assembly and material handling. For instance, we replaced the conventional long assembly lines with smaller work teams, where the individual's job was significantly enriched."

Surveys show that everybody—employees and management—is pleased with the new approach. "And it is still evolving," says Heinz Pietsch, typewriter production manager. "Now we are working on transferring more responsibilities to the teams from such indirect manufacturing areas as product engineering and production control."

*Berlin's job development program meets the approval of Jutta Jahnke, typewriter assembler. "I enjoy working on a team," she says, "and moving into different kinds of jobs. It makes the plant itself seem brighter and more cheerful."*

What is happening at the Berlin plant—which has been visited by journalists, government officials, and educators of several countries—is entirely consistent with the nature of West Berlin. "This city," said one recent observer, "is composed, self-critical, and ever open to new ideas." Nothing in its history makes likely any change in that characterization. ■

*Tabletop conference. Four members of a typewriter production group talk things over in one of the Berlin plant's meeting areas. From left: Wolfgang Alt, Dagmar Hoeck, Albert Beiche, and Hartmut Milling.*

*Heinz Pietsch, left, typewriter production manager, confers with Hans-Georg Scholz, supervisor. In addition to typebar typewriters, the Berlin* OP *plant also produces the Copier and* IBM *dictation equipment.*

IBM *Germany's president, left, with Hans Friderichs, Minister of Economy, at the Hannover Fair in April.*

Paris sees **Walther Boesenberg,** IBM Germany's president and general manager, once a month. Together with the heads of the three other largest IBM country organizations in Europe—France, Italy, and United Kingdom—he goes to European Headquarters to review the business environment in Europe, the Middle East, and Africa with EHQ staff and Area executives.

In recent months, rather than bearing the usual good tidings from Germany, Boesenberg has been reporting some somber news. For 1974 was a troublesome year. The unemployment rate surpassed 5 percent for the first time in 16 years. Inflation, though less than elsewhere in Europe, picked the pocket of wage-earner and businessman more than either of them appreciated.

IBM Germany found its own growth had slowed. Even though gross income increased by more than 10 percent, incoming orders were down, reflecting the wait-and-see attitude of the market. The automotive industry, whose IBM customers include Volkswagen and Mercedes-Benz, was particularly hard hit.

Still, Boesenberg remains confident about the resiliency of the economy, and developments thus far this year seem to justify that confidence: Industrial orders are up, inflation and unemployment down. If these trends continue, the German economy will have made its comeback.

"What we must continue to do," Boesenberg points out, "is convince our customers that data and word processing are not luxuries but necessities, that they are a good long-term investment, and that, especially under current conditions, they can help achieve needed savings and improvements."

Boesenberg believes in pressing the search for new markets. He looks to IBM's new System/32, the small, general-purpose office computer introduced in 15 European countries in April, to help attract small business and first-time users.

Walther Boesenberg has been head of IBM Germany since January 1, 1964. He joined in 1947 as a student salesman in Hamburg. After holding managerial posts there and in Sindelfingen, he became assistant general manager in 1963. A year later, he succeeded Johannes Borsdorf as president and general manager.

Today, the company he heads is not only the largest IBM organization outside the United States, but also ranks among the top 30 companies in Germany. Its 24,000 employees work in 47 cities.

In addition to plants (*see accompanying story*), key facilities include: the Boeblingen laboratory, where Models 115 and 125 of the System/370 line were designed; an industry center in Munich specializing in computer applications for manufacturing; a program product center in Sindelfingen; six DP education centers, where 72,000 customer representatives attended seminars and courses in 1974; and the Heidelberg Scientific Center, where improved detection and analysis methods have been sought in cooperation with the German Cancer Research Center.

The Heidelberg effort is especially gratifying to Boesenberg. "International companies operating in Germany today have a spotlight on them," he says. "People ask, 'What are they contributing to the society?' IBM Germany can answer that question convincingly."

# Frank Cary

**There are no limits to corporate power—at least that's what some critics of international companies would have people believe. They foresee a world doomed to 'profit maximization' and dominated by a comparative handful of corporate giants. A world in which these new centurions of business would work their will on sovereign nations.**

**Nonsense, says IBM Chairman Frank T. Cary. In a speech prepared for this year's Golden Circle meetings for marketing people from the Data Processing and General Systems Divisions, Cary takes issue with those critics and suggests what can be done to correct their distortions.**

The subject is public misunderstanding of business, and what you and I can do about it. One of the most flagrant examples is the misunderstanding of the multinational corporation.

Over the past few months you may have read, or seen reviews of, a book on the multinationals called *Global Reach.* And if you have, you know that this book portrays them as the most powerful of all institutions on earth.

* * *

The book isn't all bad. It includes many things with which I agree. I agree, for example, with virtually every one of its central concerns —for the poor people of the world; for the plight of underdeveloped nations; with its concern for American workers who lose their jobs because of technological and economic change; with its outrage over

# on international corporations

instances of business wrongdoing and corruption.

But the book illustrates what happens when the desire to drive home a point collides with the facts. I think it should have been called *Global Leap* instead of *Global Reach.* For example:

- It discovers that the annual sales of a few big corporations exceed the Gross National Product of some countries; and *leaps* to the conclusion that these companies can transform the world economy and make nation-states subservient.
- It cites a number of American corporations that have moved their manufacturing to Hong Kong, Taiwan, and Singapore. And it *leaps* to the conclusion that all industry will set up runaway plants in Asia, Africa, and Latin America, leaving the U.S. "a nation of hamburger stands."
- It finds some companies engaged in questionable bookkeeping and *leaps* to the conclusion that that is standard practice by which *all* multinationals rob the poor countries of the world.

This distortion of the evidence and false caricature of multinational corporations is dangerous nonsense.

Clearly, the more Congressmen and Senators—and their constituents—believe its distortions, the easier it becomes to pass confused legislation which will damage American business and hurt us all.

In recent years, for example, a number of Congressmen have repeatedly proposed tax legislation which would result in double taxation of the foreign income of American companies. These proposals, had they been enacted, would have resulted in raising IBM's tax rate on foreign income from approximately 50 percent to over 70 percent. Clearly, this would make it impossible for us to compete effectively overseas. Other American companies would be similarly affected.

* * *

I've cited one specific misconception about business. I could list lots of others. Recent opinion polls, for example, show that too many Americans believe corporations make far more profit than they really do; pay far less in taxes than they really do; and could be replaced by government corporations without any loss to our economy.

These misconceptions illustrate our society's great ambivalence about the free competitive enterprise system. People like to have freedom, incentives, and competition; but they don't like the consequences; they don't like to have losers as well as winners; and you can't have competition without both.

What can we do about these misunderstandings?

*First,* we have to police ourselves —make sure we as businessmen do not abuse our trust.

*Second,* we must stop making exaggerated claims for business—claims which raise false expectations.

*Third,* we must work for improved understanding of our system and, to do that, we must join the debate.

* * *

What can *you* do?

You have to keep yourself informed on issues important to business. And you have to speak out.

The misunderstandings of business are many and threatening. Their correction requires the kind of intelligence and knowledge and personal experience you men and women can bring to the debate—whether you're talking to your colleagues or your neighbors or your local editor or legislative representative.

No one can claim our system is perfect. It never has been. It never will be. But we can say it is the best of all that have been tried. We have the most productive system in the world. It's up to you and me to help preserve it and improve it. ■

# A Report on the Rese

by Richard Bode

How do you fight inflation, raise your real income, acquire more leisure time? By increasing hourly output, by getting out more products in the same unit of time. By improving the workings and the management of organizations. In a word, by productivity.

Gains in productivity enable companies to earn more, pay more, and compete more effectively in the marketplace. And they do the same for those larger groups of people that are nations.

How is it achieved, this increase in productivity? Largely through the application of technology to jobs. Through the use of more tools, better tools, highly sophisticated tools—like computers. And where do these tools come from? Out of what we call R & D.

The National Commission on Productivity sums up the relationship nicely in its 1974 annual report: "The pace of productivity change in a technological society depends, to a great extent, on the application of scientific knowledge to production—and therefore on the amount of resources devoted to research and development."

## Free as a bird? Not quite.

But the freedom given the scientist to search and to soar into the unknown is the essence of discovery. Says Ralph Gomory: "Scientific research is difficult, extremely difficult. But if you have good people and expose them to real problems and give them sufficient freedom, then something is bound to happen."

# arch Division

The computer provides a dramatic case in point. Not just another tool, it has become an almost universal productivity "engine." As a result, any technological advance that improves the performance of the computer is likely to spread productivity gains throughout the economy.

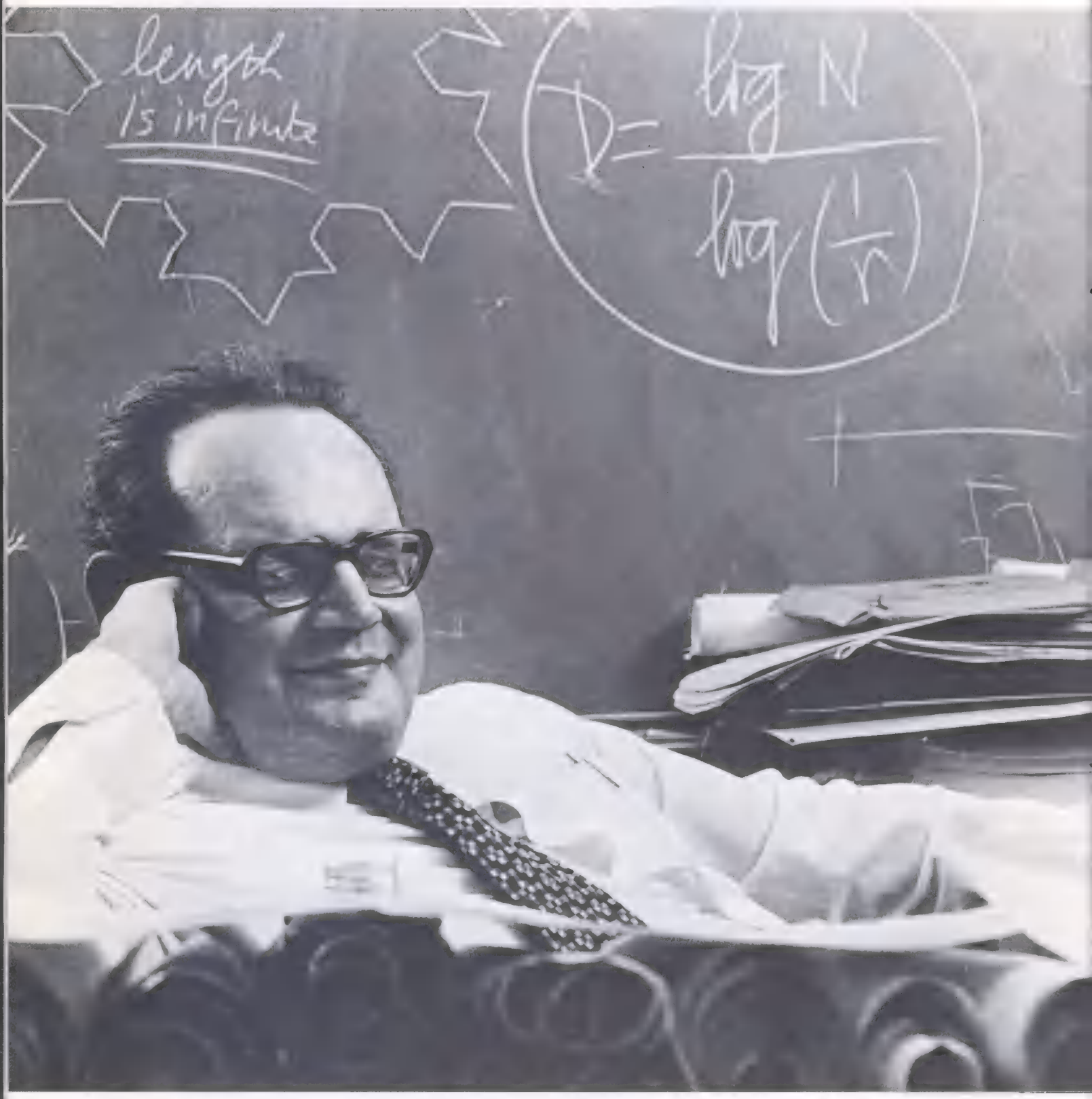
But where do these technological advances come from?

Unlike Athena, they do not spring full-blown from the head of Zeus. In a company like IBM, all divisions contribute to technological advance. This is certainly true of development divisions, which translate ideas into manufacturable products; of manufacturing, which finds more efficient ways of turning them out; and of marketing, where the entire process often begins with an assessment of customer needs.

But within IBM, it is the Research Division that takes on technological progress as its primary mission. How does Research perceive that mission? How does it go about achieving it? Most important of all, how does it cultivate those new ideas that move the business forward?

Those are some of the questions explored in the following report.

# Q Do you push existing technologies? Or put your money on alternative ones?



# A In research, you do both. At one and the same time.

A popular misconception about scientific innovation is that all new technologies emerge in the same manner. New ideas, it is assumed, originate with the discoveries of those in pure, or basic, science. Then applied researchers translate those findings into feasible devices, which they turn over to development engineers. That notion stems largely from the mistaken idea that science always comes first, and technology always follows. In truth, there is considerable interaction between the two.

A major strength of the Research Division is that it is one of the few organizations that span both worlds. Science and technology occur side by side. They reinforce each other, and joint efforts by scientists from both areas take place before the feasibility of any new technology can be shown.

This dual orientation is considered fundamental to the company's research effort. In fact, it was identified as a value worth fostering 19 years ago when Dr. Emanuel R. Piore (now retired), who became the first director of research and subsequently the company's first chief scientist, literally forged the Research operation from a number of discrete elements.

But 19 years in the life of a research organization is a mere flicker in time. It takes years to build strengths in scientific disciplines, to gain momentum. Today, an unmistakable current runs through the division—the sense of excitement that comes to an organization as it grows fully conscious of its strength.

* * *

**Benoit B. Mandelbrot**
mathematician

One might easily itemize the ways Research has contributed toward understanding the behavior of materials or the building of devices. The list would occupy several pages. But it would be just that—a list. It wouldn't put into perspective the underlying philosophy that governs the way the division approaches its work.

Stated as simply as possible, Research strives to accomplish three goals at the same time:

- Conduct scientific studies in areas of IBM interest.
- Push existing technologies to their uttermost limits.
- Explore alternative technologies to those presently in use.

A few examples:

In storage, the division pushes disks and tapes while it explores magnetic "bubbles." In logic and memory, it pushes semiconductors while it explores a new ultra-fast circuit technology based on the Josephson junction. In output devices, it seeks to supplant impact printers with ink jets. In computer science, it seeks hardware and software that will make the computer easier for nonprogrammers to use.

Virtually all the division's work in advanced projects flows from this fundamental concept of pursuing existing and alternative technologies at the same time. And while the projects may be easy to identify, the implications of the approach are often profound.

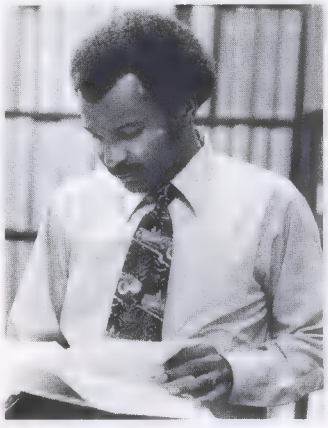
Why, for example, push an existing technology if you have an alternative technology that seems patently superior? The answer, of course, is: "Superior to what?" The present state of a technology may not be a clear indication of its potential. Only by pushing that technology to its limits can you determine its ultimate worth.

Magnetic disks and tapes serve as a case in point.

"People have been predicting the demise of magnetic recording for twenty years," says Dr. Al Sporer, manager of applied science in San Jose. "But all such predictions have proved premature."

Most of the advances in disk and tape technology over the last 20 years stemmed from the concentrated work of engineers in the development divisions, mainly in San Jose and Boulder. Today, Research scientists are helping General Products Division engineers push the technology even further.

When disks were first introduced, for example, it was possible to pack 1,000 bits of information per square inch. By pushing existing technology, it may be possible to store as



**Dr. William A. Lester, Jr.**
*Research staff member*
*San Jose*

Dr. William A. Lester, Jr., is one of those men who feels equally at home on the athletic field and in the laboratory. He was captain of the basketball team at the University of Chicago, where he holds the record for scoring the most points (42) in a single game.

Today Dr. Lester is better known for his contributions to theoretical chemistry, where he uses the computer to help determine what happens when atoms and molecules collide. "By understanding basic phenomena in these collisions," he says, "we can selectively enhance or retard chemical reactions and the transfer of energy." He was the first to show the feasibility of making potential energy surface computations involving molecules other than hydrogen for scattering studies.

Dr. Lester, a native of Chicago, earned his Ph.D. at the Catholic University of America. Before joining IBM in 1968, he was a lecturer in chemistry and assistant director of the Theoretical Chemical Institute at the University of Wisconsin.

He maintains his interest in teaching. In a joint study with the University of California at Berkeley, he is currently participating in the supervision of two doctoral candidates whose theses deal with molecular collision. "We have capabilities in the IBM lab," he says, "that simply are not available to qualified students at universities anywhere."

many as 100 million bits per square inch.

How will such great densities be achieved? Mainly by constantly reducing the distance between the magnetic recording head and the surface of the disk. The closer the head "flies" to the disk without actually touching the surface, the smaller the magnetic bits can be. And the smaller the bits, the greater the density.

When IBM first brought out RAMAC (Random Access Method and Control) in 1956, the head was flying 25 microns (1 micron equals 1/25,000 of an inch) above the disk surface. Today the head is flying several microns (or a few millionths of an inch) above the surface. But the goal is to bring it even closer. That presents engineers and scientists with seemingly insuperable tasks. The problem has been likened to flying a jumbo jet at full speed at precisely one foot off the ground.

At the same time, scientists and engineers are continuing to explore the radical alternative to disk and tape storage: magnetic bubbles.

The term *bubbles* is something of a misnomer. To the layman, the word evokes the image of bubbles produced by boiling water. Actually, bubbles are tiny magnetic regions that are created in thin magnetic materials. They can be moved around within the material, by rotating a magnetic field, and detected by electronic sensing devices. The presence or absence of a bubble at a particular point can be made to correspond to the zeros and ones of computer language.

Because of their attributes, magnetic bubbles potentially could form the basis for new storage devices that eliminate moving mechanical parts and have densities of over 1 billion bits per square inch.

Are bubbles superior to disks and tapes? If these technologies were not being pushed, the answer today might be an unequivocal "Yes." But because they are, the company is now in a position to assess the merits of each. It knows, for example, that disks and tapes may be suitable for some applications; bubbles for others.

To date, bubbles are still a laboratory project. But someday, because of the dual research efforts, bubbles, disks, and tapes may co-exist in the marketplace.

* * *

The division's scientific studies, which engage about one-third of its researchers, might seem divorced from reality until viewed in context.

In some of these studies, scientists attempt to uncover the outer boundaries of physical phenomena. After all, if one is going to push technology to its limits, it helps to know, as one researcher puts it, "exactly how much you can wring from nature."

In one critical study, Dr. Shmuel Winograd, an IBM Fellow and pioneer in the field of computational complexity, has found the limits of computation in some important areas. Dr. Winograd determined that, regardless of the numbering system employed, there are a minimum number of logical steps required for addition, multiplication, and other more complex mathematical operations.

On the face of it, Dr. Winograd's findings may sound like one of those exercises that fascinate mathematicians and confound everyone else. In fact, his findings have practical implications for the way circuits are arranged in the central processing unit, where those logical steps are carried out.

Dr. Winograd showed that circuitry design had approached its limits; there were no more shortcuts. No matter how you rewired logic, you couldn't materially increase computational speeds. To increase the computer's capacity, you had to fabricate smaller circuits and develop faster switches. And that's exactly where the division has focused its efforts.

Some of the most important work today in logic and memory pertains to fabrication techniques. The objective: to make circuits that are smaller and, consequently, more dense. Smaller circuits operate faster and consume less power. As circuit densities increase, costs

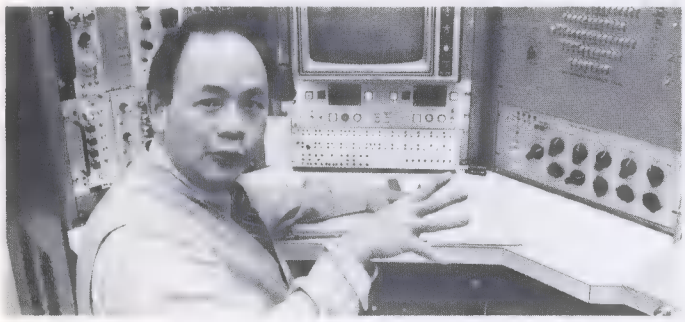
Dr. T. Philip Chang keeps a special exhibit on his desk. It's a plastic wafer that measures 1½ inch square. If you examine that wafer under a microscope, you can read the Bible, all 1,250 pages of the Old and New Testaments.

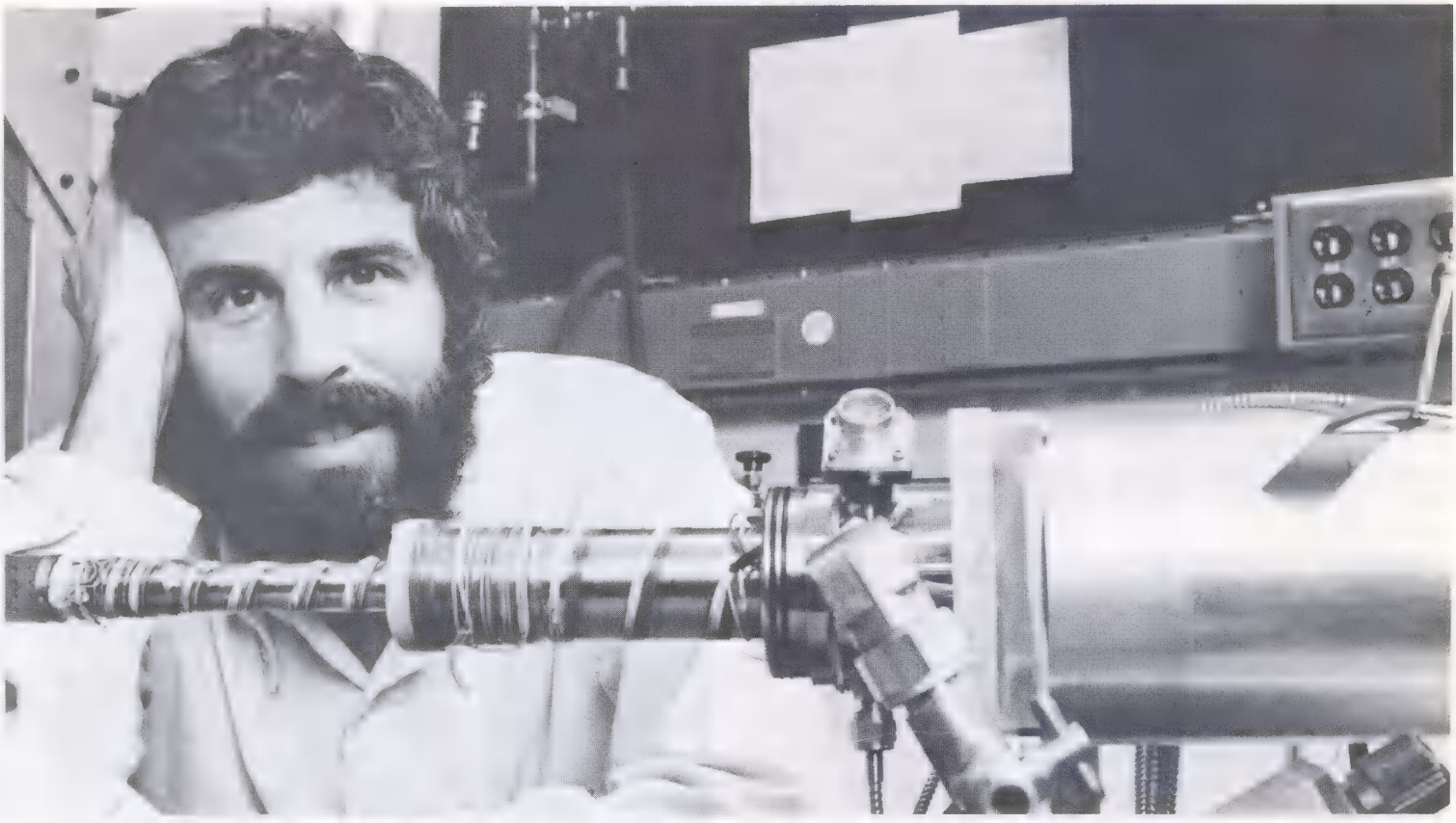
The wafer was made by focusing beams of ultraviolet light along the light-sensitive surface of the wafer. "As small as this printed Bible is," says Dr. Chang, "we know we can make it even smaller. By focusing electron beams, instead of light waves, we can print the entire Bible on a wafer ⅛ inch square."

This electron-beam fabrication technique, which scientists and engineers at Research and other IBM divisions are working to perfect, has enormous implications for computers. It can be used to create circuits ten times smaller than those being printed now. "As a consequence, IBM computers will become smaller and faster," Dr. Chang explains, "their capacities will become greater, they will consume less power, and their cost per function will go down."

Dr. Chang joined IBM four years ago. He trained as a civil engineer at the University of Hong Kong. Then he went to Cambridge University in England to earn his doctorate in electrical sciences, a field that encompasses electrical engineering and physics.

**Dr. T. Philip Chang**
*Manager of electron-beam fabrication systems*
*Yorktown Heights*





**Richard L. Greene**
experimental
physicist

decrease—both for IBM and its customers.

Circuits today are printed on silicon wafers. Thousands of tiny electronic devices are formed on the wafers by repeating various photographic, etching, and chemical processes. This technique, which the division pioneered, is known as Large Scale Integration because it joins many circuits on a single silicon chip.

The objective is to make the lines of the circuits as narrow as possible. The narrower the lines, the smaller the circuits. Here again we bump up against the question of limits. How narrow a line can one make?

A group of scientists at Yorktown Heights investigated the limits of line width. They found it was possible to pack more transistors onto a silicon wafer than current technology permitted. But one would need a finer instrument than light. One would need to draw circuits with electron beams. With electron beams, one can create circuits ten times smaller than those produced with light.

In recent years, the division has assiduously pursued electron-beam fabrication and pushed it to an advanced stage. The following figures illustrate the importance of research into fabrication techniques:

In System/360, using hybrid fabrication techniques, there are 16 transistors per square inch. In System/370, using photolithography, there are hundreds of thousands of transistors per square inch. In the future, using electron beams, there may be millions of transistors per square inch.

Electron beams can be used to fabricate not only semiconductors, but also magnetic recording heads, bubble memories, and tiny Josephson tunneling junctions that may someday replace transistors in logic and memory.

The great virtue of electron-beam fabrication is that it puts IBM firmly in the field of microminiaturization, a theme that pervades the Research effort. So important is the fabrication of ultra-small devices to the future of data processing that Dr. Ralph Gomory, IBM vice president and director of research, was once prompted to observe: "Smaller is faster. Smaller is cheaper. In our business, smallness is goodness." ■

# Q Where does science cut off? And technology begin?

"It's always possible for a company to introduce a new product or technology it doesn't fully understand," says Dr. John Armstrong, acting director of the physical sciences department at the Thomas J. Watson Research Center in Yorktown Heights. "But that's a dangerous procedure. When difficulties arise, as they always do, then it becomes hard to sort things out if you don't know what you're doing. To prevent this kind of catastrophe from happening, science and technology should be interconnected. They should be one big seamless web."

In the Research Division, that web encompasses far-flung activities in three laboratories —the Thomas J. Watson Research Center in Yorktown Heights and the labs in San Jose and Zurich. Roughly speaking, about 35 percent of the Research staff is engaged in science, and 65 percent in advanced projects. An important role of science is to gain a fundamental understanding about why things happen as they do. The role of advanced projects is to pursue existing and alternative technologies. But keeping the two a "seamless web" takes some doing.

"Interaction among those groups doesn't always happen automatically," says Don Rosenheim, director of the San Jose laboratory. "The natural tendency is for those in physical science to gravitate toward academic work, and for those in applied research toward product development." One of the main jobs of Research management, as Rosenheim sees it, is to create joint projects that pull the two groups closer together.

There are abundant examples of the benefits that accrue when those in science and those in advanced projects pull together.

In one project, for example, physical scientists studied the chemical reactions that take place when electron beams penetrate a chemical coating. Their findings are helping applied researchers develop a new class of materials for electron-beam fabrication.

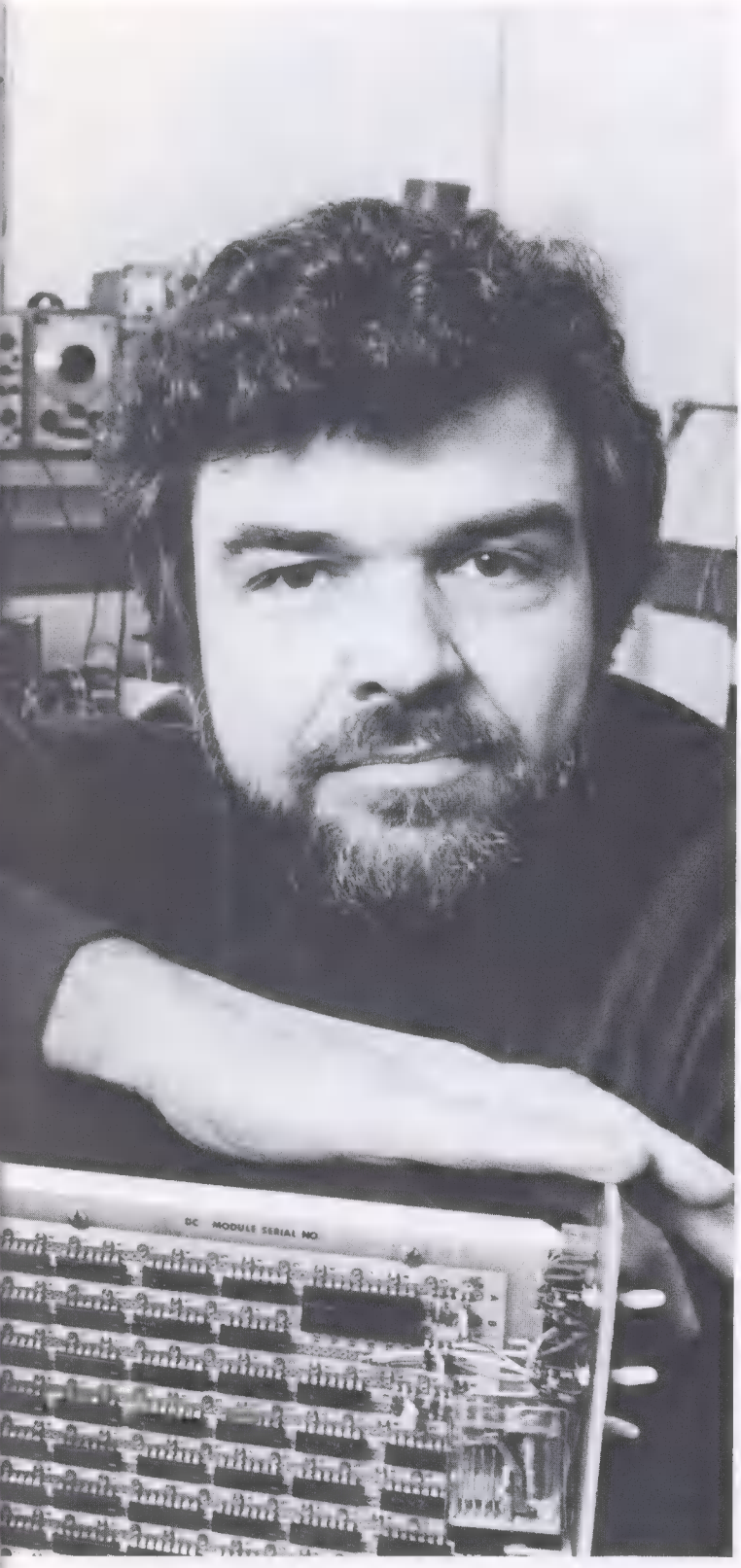
In another project, the math department is working with the computer systems department in cryptography, mathematical techniques for scrambling data to prevent unauthorized users from deciphering data even if they gain access to it. The technique is already being used in the IBM 2984 cash dispensing terminal for banks.

Perhaps more than any other discipline, mathematics indicates the cross-pollination that takes place among scientists. "One often thinks of mathematics as a dry, lonely subject," observes Richard Toupin, director of the mathematics department. "But, in the environment we have here, mathematics becomes quite lively." The work of the mathematicians enriches many areas, including design automation (that is, the best way to lay out logic circuits on a chip), character recognition, network analysis, as well as cryptography.

In yet another project, physical scientists investigated the wall characteristics of magnetic bubbles. They found not all bubbles are the same. Their findings have enabled applied researchers to build bubble devices quite different from those that had been foreseen earlier.

In some cases, physical scientists will approach an ap-

# A You don't draw the line. The object is to pull the two closer together.



**Lawrence B. Kreighbaum**
specialist in automating
lab equipment

plied researcher and say: "Look, we've found out something new and useful which may be of interest to you." In other cases, the applied researcher will approach the physical scientists and say: "We're stuck! We need to know more about the chemistry of this material before we can build a suitable device." In still other cases, the applied researcher may help stimulate the efforts of the physical scientist.

Without doubt, one of the best examples of the interaction between science and technology is the Josephson tunneling junction.

The underlying physical principles for the Josephson tunneling junction are based on the work of two Nobel Laureates, Dr. Brian Josephson, the British scientist, and Dr. Ivar Giaever of General Electric. (Electrons act both as particles and as waves, and as waves they can "tunnel" their way through a barrier.) But the first person to build a switching device for computers using this kind of electron tunneling was Dr. Juri Matisoo of the Yorktown Heights laboratory. He began exploring superconductivity back in 1965, soon after he joined IBM fresh out of doctoral studies at the University of Minnesota. "It wasn't exactly an accident, but a kind of historical accident, if you know what I mean," he says. "It was one of those things that happens sometimes."

Dr. Matisoo says he was "rummaging" through scientific literature when he came upon some experimental results on the Josephson effect. Looking at the experimental data, he realized it might form the basis of a very fast computer switch. He began to build preliminary, experimental devices. The work showed that his hunch about the high potential speed of the device was correct. It also showed that the devices are really based on a combination of Josephson and Giaever tunneling. At the time, he was part of a five-man team in the physical sciences department. Today, Dr. Matisoo is a manager in the exploratory cryogenics technology department, and work on the Josephson junction engages many researchers in both Yorktown Heights and Zurich.

Dr. Matisoo expresses "guarded optimism" about the potential of the junctions, which have higher switching speeds and lower heat dissipation than any other known electronic device.

Does all this mean that the division only supports projects that might be of value to IBM products?

Dr. Seymour Keller, former director of physical sciences at Yorktown Heights and currently a consultant to Dr. Ralph Gomory, puts the answer in perspective. He cites three reasons for supporting a project.

"If the project maintains or extends a needed capability, then you support it on that basis," he says. "If it has a potential application, then you support it on that basis. But there's a third criterion. If the project is exciting—genuinely exciting—because it's on the forefront of science, then you support it on that basis, too."

Dr. Keller affirms that excit-

ing projects are hard to define and harder to find. But he feels that when one appears, there is near unanimous agreement among scientists that it must be pursued. "The work we've done in lasers is exciting," he says, "and so is the work we've done in ultrasonics.

"We want to do exciting things in science, even if we aren't sure of their relevance to the computer, because we don't know where they'll lead."

Indeed, scientific fields once deemed irrelevant have ways of suddenly becoming important. "Ten years ago," says Dr. Armstrong, "if somebody asked what sort of physics we should be interested in, the answer was invariably that we could be interested in any kind of physics so long as it was low-energy physics. By that I mean below 100 electron volts. Today we have three accelerators here in the building—one over 2 million electron volts, which might some day be used to fabricate computer circuits."

The need to take extraordinary risks helps explain why, in IBM, research can't be tied into a development cycle. In development, the work ultimately must be scheduled and turned into a product.

"In Research," observes Mike Canon, former manager of technical planning who has returned to Research in computer science, "we're not trying to produce Product A at Time B at Cost C. We need to be free of the pressures of time. We need to explore and change directions if necessary."

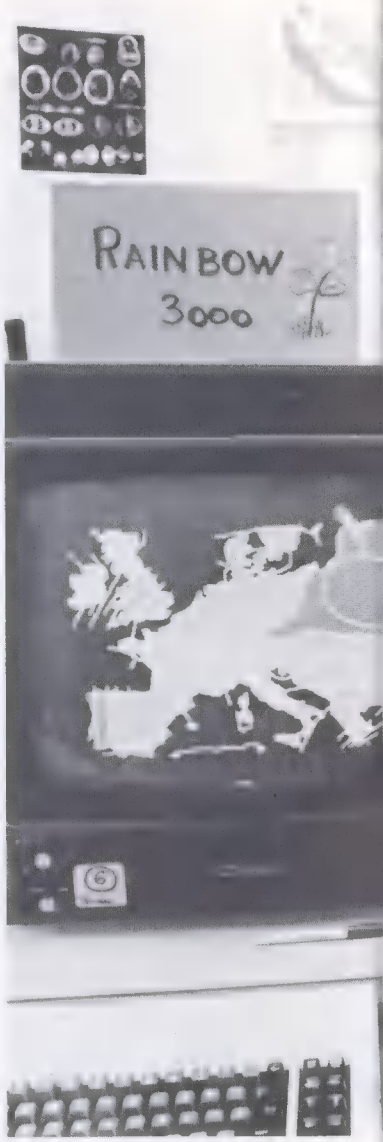
* * *

How then does the Research Division decide when technology is ready for development? How does it move the technology out of Research into a development laboratory?

Roughly speaking, what the Research Division must do is prove the feasibility of a technology. Scientists must show that at least *one* functional device can be built. The development labs then evaluate and further refine the technology, and adapt it to the needs of the marketplace.

To a large extent, the applied research departments in both Yorktown Heights and San Jose serve as bridges between the Research Division and the development laboratories in the product divisions.

In San Jose, for example, there exists a multidivisional applied science complex, guided by Dr. Al Sporer, which includes not only applied researchers, but also development engineers and scientists from the Office Products Division and the General Products Division.




OPD involvement is largely an outgrowth of the research and development of the IBM Copier. The organic photoconductor, on which the Copier technology is based, is considered one of the Research Division's prime achievements in the noncomputer field.

The GPD group is deeply involved in storage devices, espe-

**Patricia Goldberg**
*Manager, automatic programming*
*Yorktown Heights*

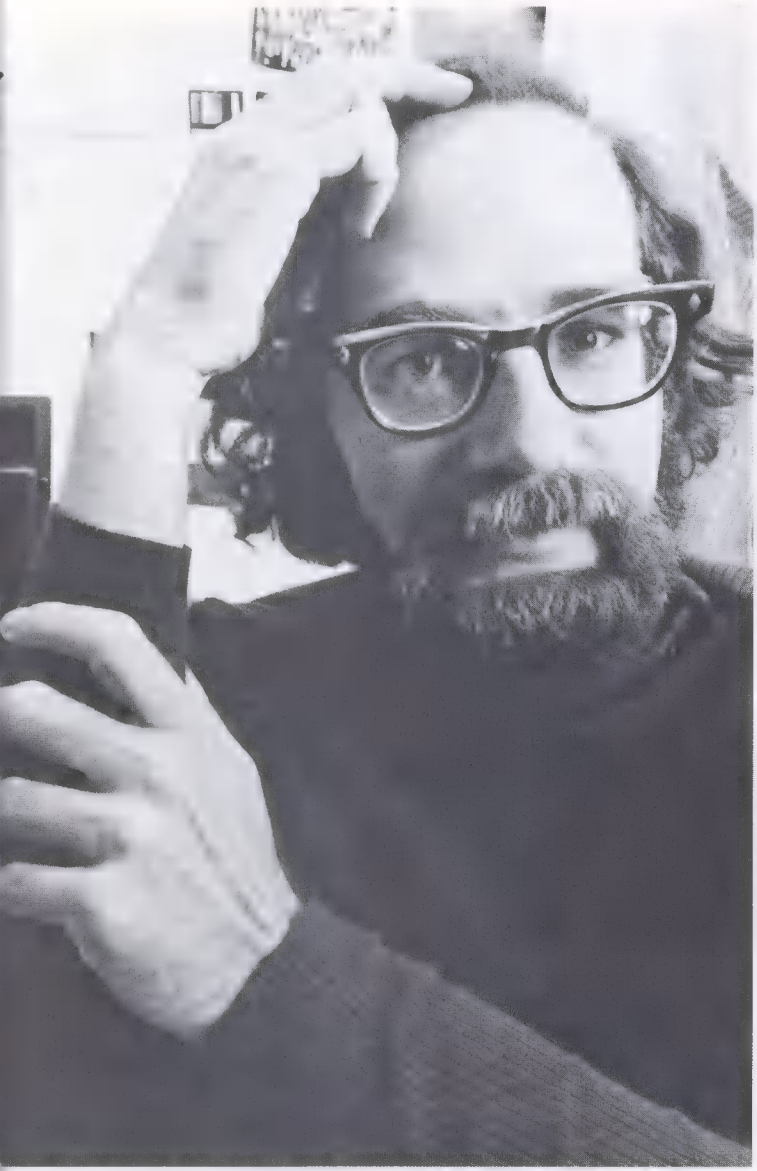
"Several years ago," says Patricia Goldberg, "I got annoyed at the shape of Research's effort in compilers, and said so. Suddenly I found myself doing something I vowed I would never do: managing a compiler group."

Today, Pat Goldberg is managing the automatic programming group, which consists of about 40 computer scientists who are trying to make the computer simpler for the nonprofessional programmer to use.

"We're interested in helping those end-users who don't have skills or aptitudes in abstract reasoning, the kind of ability usually thought of as a prerequisite for programming," says Mrs. Goldberg.

"We're not interested in building application programs," she adds. "We're interested in building methods that will let people who aren't trained programmers use the resources of the machine to specify their own applications. So it's not applications programming that interests us. It's applications methodology."

Mrs. Goldberg, a graduate of Clark University, joined the Research Division in 1966. She is married to Dr. Richard Goldberg, who is also a computer scientist at Yorktown Heights.



**Gary M. Giddings**
computer scientist

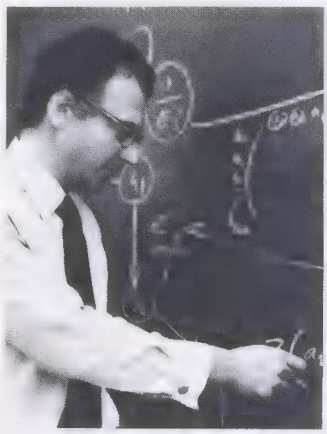
cially bubble technology. When products that pertain to either of these divisions are judged to be at the "feasible" stage, then members of these groups could possibly move with them to the development laboratories in their respective divisions and translate them into manufacturable products.

In Yorktown Heights, there also exists the Manufacturing Research Laboratory, a group of 25 engineers that reports to the System Products Division but has certain interdivisional responsibilities. "Our job," says John Little, manager, "is to examine new product programs that have a high probability of going into production and to anticipate the manufacturing problems."

There are no hard and fast rules that indicate when a research project has reached the feasibility stage. Those decisions are made on an individual basis by Corporate and divisional management. In most cases, there is general agreement about when a product's time for development has arrived. On rare occasions, differences of opinion arise.

One such occasion surfaced a decade ago when the Research Division felt it had completed its work on field-effect transistors, which are now the major memory technology. The division's faith in FETs, however, was not widely shared.

To make its point, the division proceeded to build a pilot line in the Thomas J. Watson Research Center, where it produced the devices in quantity. Today, FETs are a major component of System/370. ■



**Dr. Pitro Zafiropulo**
*Research staff member*
*Zurich*

Dr. Pitro Zafiropulo is a man who moves easily between the theoretical and applied worlds of scientific research. "If I do just theoretical work too long," he says, "I tend to go off on a tangent. Being brought back to real life tends to improve the theoretical when I return to it."

Of late, Dr. Zafiropulo's work has veered to the applied side. His work within the Data Network Group, a part of the communication research activity in Zurich, is directed mainly toward exploring techniques that will allow IBM products to interface with future data networks. "The work is especially important in Europe," he points out, "where networks are generally government-owned, and technical development is more diverse than in the U.S."

But his work has worldwide application, too. Currently, he is studying ways to combine line-switching techniques, which predominate in the U.S., with packet-switching techniques, which are planned for some countries in Europe. "We are investigating a network that would have both services," he says, "so users can pick the one they want."

An inveterate mountain-climber ("I'm addicted to vertical rock faces," he says), Dr. Zafiropulo has a diverse background. His father was Greek and his mother Austrian. His wife is English. His native tongue is French, although he speaks flawless English. He was educated in South Africa, Scotland, Austria (the University of Innsbruck), and Switzerland (The Swiss Federal Institute of Technology).

# Q How do you stimulate the search for new discoveries, give impetus to invention?

Dr. Denos Gazis, until recently director of the department of general sciences in the Research Division, likes to repeat a conversation he had during an interview a few years back with a bright young physicist who had just received his doctorate.

The physicist was explaining how much money he could earn by remaining at his university and working under a government contract. There was his salary . . . plus his summertime teaching . . . plus outside consulting fees.

Dr. Gazis recalls his own tongue-in-cheek response, a reversal of an old selling point made by university administrators: "I told him that his university might offer him more money. But we could offer him more academic freedom here.

"It wasn't exactly a joke, either," Dr. Gazis adds.

Dr. Gazis doesn't say if the young scientist accepted—or was even offered—a job in the Research Division. But his half-jesting response suggests the environment the division strives to create for the people it recruits.

Today, the division employs 1,600 people in its three laboratories. Of those 1,600, 750 are members of the professional Research staff; about 560 hold Ph.D.'s. About 850 are administrative and technical support people.

"The unique thing about our staff professionals," Dr. Gazis observes, "is that they're not trying to move ahead in the traditional sense. They're not trying to climb the proverbial ladder of success. What motivates them is the work they do. What they want most is a chance to make a significant contribution to science and technology, and to be recognized for that contribution by their peers.

"And so, what we try to do is create a working environment in which they can fulfill their own ambitions and serve the company at the same time."

That doesn't mean, he points out, the scientists aren't interested in some of the same rewards as other people—or that other people are indifferent to their work. It does mean that advances in science invariably stem from the efforts of researchers working on their own.

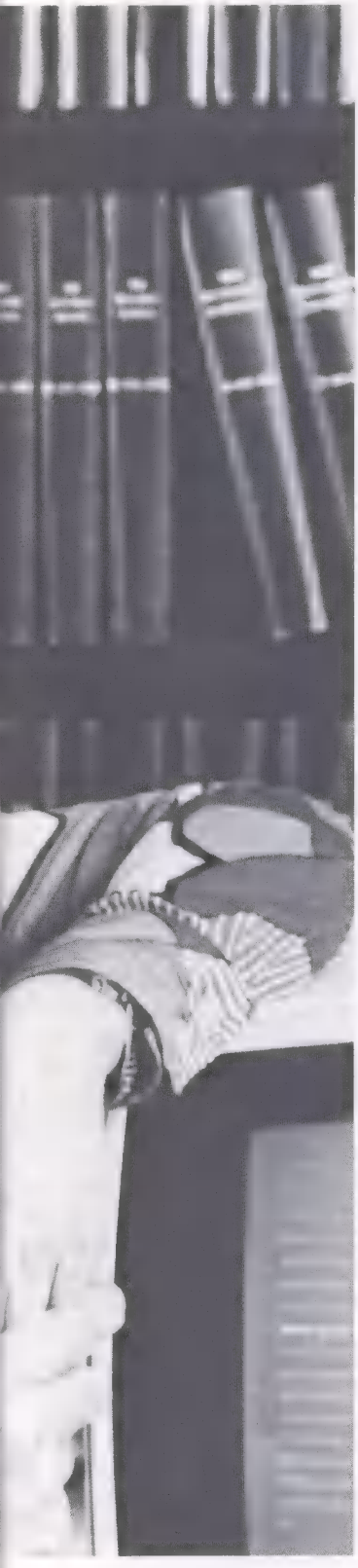
"In this division," Dr. Gazis points out, "we have a tradition of minimum interference with scientists, once they've proven themselves. But to prove themselves they must demonstrate they have the ability to generate their own ideas and see them through."

Academic freedom, of course, is a relative thing. It finds its most natural place in the general sciences department, which more closely approximates an academic community than any other department in the division. It even changes its director every two years to make sure nobody gets bogged down in management chores. Following his own stint as director, Dr. Gazis, an applied mathematician, has become manager of the social science group in his old department, as well as special consultant to Dr. Ralph Gomory.

The department has heavy commitments to both the life sciences and social sciences. In the social sciences, there is a strong emphasis on mathematical modeling and computer simulation techniques. "We

**Alice T. Lean**
library specialist

# A Find good people and create an environment that enables them to generate their own ideas.



have a feeling," says Dr. Gazis, "that computers are powerful tools that we have not yet fully utilized for the social good." He, himself, has become an expert on traffic control and has authored books and papers on the subject. "Instead of suffering with the rush hour traffic problem," he says, "we are trying to mathematize and control it." He is closely identified with the simulation techniques that improved traffic flow by 10 percent in New York City's Lincoln Tunnel.

Other successful mathematical models have simulated the financial life of housing projects, the growth of forests, and the network of streams. All, obviously, are areas of intense social interest.

In life sciences, the department, among other projects, has been studying the protein structures in photosynthesis. As a result of this study, several scientists have uncovered a new way to synthesize hydrogen, a valuable fuel.

In the general sciences, as in all departments, there is wide latitude for independent work. The emphasis is on finding good people and leaving them alone.

"If you really have a group of good people," says Dr. Gomory, "it will take a determined management to keep them from inventing something. Good management can help make the results less random—so they respond to IBM needs."

* * *

Scientists who join IBM come from almost everywhere in the scientific community. As one might expect, however, the great majority are recruited from the universities. It is the universities that train, nurture, and harbor the best minds.

In a classic understatement, Dr. Varadachari Sadagopan, manager of university and scientific relations, who coordinates Ph.D. recruiting companywide, describes the quest for first-rate minds as a "serious business." It is, in fact, a matter of survival, the subject of an intensive search by nearly 100 technical representatives, all of them IBM employees, from a number of different divisions.

These representatives follow what Dr. Sadagopan calls "the key school concept," that is, they maintain ongoing relationships with the graduate scientific departments of about 30 universities. Each representative is assigned a specific department at a specific school to identify promising postgradu-

**Dr. Frank E. Talke**
*Manager of mechanics and hydrodynamics*
*San Jose*

Dr. Frank E. Talke didn't lack job offers when he received his Ph.D. in mechanical engineering from the University of California at Berkeley in 1968. He was pursued by some of the most prestigious companies and universities in the country. He joined IBM because, as he puts it: "I had a chance to work in an area where several scientific fields come together." That area was magnetic recording, where such diverse disciplines as fluid mechanics, electronics, lubrication, magnetics, and chemistry merge.

Dr. Talke is an expert in tribology, the study of friction, wear, and lubrication. He teaches the subject at the graduate level at the University of Santa Clara. At IBM, his work—along with many others—has been instrumental in allowing recording heads to "fly" as close as possible to disks and tapes (within a few millionths of an inch) without actually "crashing" (touching the surface of the disk).

A native of Dresden (he was five when Allied bombers destroyed the city), he worked as an industrial model-maker before attending the University of Stuttgart. He came to Berkeley on a scholarship, intending to return to Germany. But his wife, Kathryn, whom he met while a student, and a challenging job offer from IBM have long since converted him into a confirmed Californian.

ate students during their predoctoral years and watch their intellectual development. After the student has earned a Ph.D., he or she is invited to give a seminar to division scientists based on his or her doctoral thesis. Not uncommonly, the student goes on to become a postdoctoral research associate somewhere before joining the company.

Each year, the division hires between 30 and 40 scientists.

IBM makes a determined effort to aid graduate students and their universities in the most tangible way possible—through the creation of special fellowships. Last year, under the program administered by Research, the company awarded over a half-million dollars to some 70 predoctoral fellows, including 18 members of minority groups and women. In addition, some $200,000 goes to 15 postdoctoral fellows. Currently, those 15 fellows are at eight different universities and in five different scientific disciplines. "The grants represent a major commitment to scientific support," says Dr. Sadagopan.

* * *

The moment scientists join the Research Division, they become members of the professional Research staff. They are treated at once as equals among peers. There are no job gradations (such as senior engineer, advisory engineer). Titles with the word "manager" or "director" in them are mainly convenient labels.

To head a department, it is universally agreed within the division that a scientist must be technically qualified. Otherwise, the manager can't make necessary judgments. But scientists who are technically qualified are quite often "itchy" to return to creative research work.

Perhaps the prime characteristic of the division is the enormous mobility of the professional staff. A researcher may be absorbed in his or her own project for a number of years, then become a manager for a few years. Or go on sabbatical for a year, and then return to laboratory work. The movements, seemingly, may be lateral. But the researcher's life as a scientist has been enriched.

"The professional technical person must be retrained and refreshed," says Dr. Arthur G. Anderson, Ralph Gomory's immediate predecessor as director of the division. "In a mature, technical organization, this is a necessity. A professional person is one who is constantly learning." Dr. Anderson accepted his own advice. In 1970, he left his position to become a Fellow at the Center for the Study of Democratic Institutions at Santa Barbara. Today, he is an IBM vice president, and president of the General Products Division.

The subject of vitality is one of consuming interest within Research. A "vitality program" has been in effect for a number of years to make sure scientists are, as Dr. Anderson suggests, "retrained and refreshed." The cornerstone of the program lies in sabbaticals.

There are three types of sabbaticals, and they last anywhere from three months to a year. All are designed to broaden the education and experience of the individual.

One sabbatical is purely internal—the scientist spends some time in a different department or Research laboratory. A second is interdivisional—a scientist spends up to a year in, say, the Data Processing Division, mixing with marketing representatives and systems engineers. The result: a better idea of what is relevant to the company.

The third type of sabbatical is to an academic institution virtually anywhere in the world. During 1974, 20 scientists were on internal sabbaticals, 38 on divisional sabbaticals, and 37 on university sabbaticals.

The university sabbatical not only broadens the scientist, but also benefits the company. As Dr. Piore foresaw, one of the important functions of the division is to keep the company informed about what's happening in the scientific community, especially in areas vital to its business. The fact is that company researchers feel they serve

**Dr. Alex Malozemoff**
*Research staff member*
*Yorktown Heights*

Dr. Alex Malozemoff was invited to join the Research Division after completing postdoctoral studies in magnetic oxides at Oxford University.

"I wasn't told to go on doing exactly what I had been doing before," Dr. Malozemoff recalls. "Rather I was given the chance to go into something a little different—and that has made a big difference in my professional life." He believes the worst thing that can happen to a creative scientist is to become "stuck in a rut . . . to go on working in the same area with the same laboratory equipment all the time."

Dr. Malozemoff, who completed his doctoral work in physics at Stanford, decided to study magnetic bubbles (microscopic domains within thin films), an area of vast potential for data storage. Working in the physical science department, he has uncovered what he calls "a curious phenomenon"—the fact that not all bubble walls have the same structure. Although his findings have opened new approaches to the development of bubble devices, he says he "stumbled by accident" on the phenomenon by which one bubble domain can be distinguished from another. But he adds that "accidental discoveries" of that kind can only occur in an environment where the scientist is free to pursue his or her own interests.

both IBM and the scientific community at the same time. As one physicist expresses it: "Our contributions are measured not only by our company, but also by our academic peers."

Dr. Hirsh Cohen, chairman of the newly established Research Review Board, which has a mandate to undertake long-range planning for the division, says: "Most of our scientists joined the division during the 1960s. Many of them have made enormous contributions, but they still have many years left to be productive. We want to make sure they are renewed as scientists and constantly stimulated."

Besides Dr. Cohen, the board's members include Dr. Seymour Keller and Dr. Donald N. Streeter, formerly director of the computer systems department. And while the three will be interested in revitalizing scientists, it will not be their only focus.

"The main reason for our existence," observes Dr. Cohen, "is that we may just offer a different view . . . that is, a view different from the department directors and Dr. Gomory's staff. We can step back and review a situation objectively because we are not tied to resource allocations and budgets. We're an independent source of data and observations and feelings about what's going on."

In a sense, the Review Board is to the division what the division is to the entire company—a source of objective opinion.

"We have a strong responsibility *not* to do what we're told," says Ralph Gomory, "but to present a different, independent, and objective view of what is needed. And then to formulate a Research program that addresses those needs."

It is mainly for that reason that the Research Division was conceived as an independent organization that obtains its funding directly from the corporation, and not from each of the divisions. (The director of research reports directly to the Corporate Office.) That degree of independence allows it to conduct advanced projects without being brought up short by the daily pressures that preoccupy other divisions.

The benefits to both IBM and its customers are perhaps best stated by Dr. Keller: "It is commonly assumed," he says, "that technological innovations stem from demands from the marketplace. But this is only partly true. More often than not, the marketplace doesn't know what it can aspire to until technology points the way." ■

*Richard Bode, a freelance writer who specializes in business subjects, wrote the section on nuclear energy in the July/August '74* Think.

**Gerald L. Ayers**
automation engineer

# A conversation with Ralph Gomory

*In a wide-ranging discussion with journalist, Richard Bode, Dr. Ralph Gomory,* IBM *vice president and director of research, talks about the purpose of research, the nature of invention, and what it takes to achieve success in science and technology.*

### On research in industry

When we talk about an industrial research organization like IBM, we should be quite clear about how it fits into the wide world of science and technology. There's a lot of fundamental research going on, most of it in universities, and there's a lot of short-term product improvement, most of it in industry. But there's a very large gap in between. IBM is one of those few organizations with the capability to pursue fundamental research and at the same time relate to the problems of the real world. The only organizations with that kind of capability are the large industrial research groups like ours, and you can count them on your fingers or, if you're being generous, you can add your toes.

* * *

The purpose of fundamental research is to increase human knowledge rather than contribute something immediately useful. There's all sorts of scientific knowledge, of course, and nearly every company has a stake in some branch of it. But few companies try to advance scientific knowledge directly through their own efforts in their own research laboratories. We do. At the same time, we're very much interested in the practical aspects of the data processing business. I mean the devices, the products, the technology. It's this connection with science, on the one side, and daily life—so to speak—on the other, that gives us our vitality.

### On the cross-pollination of ideas

In the Research Division, we have knowledge-oriented scientists tied into the same world as university scientists. That's terribly important. The Josephson effect emerged from the university world. Brian Josephson received a Nobel Prize for his work in low-temperature physics. The work was quite esoteric, but we had people interested in low-temperature physics and the Josephson phenomena. The university people weren't the least interested in pushing Josephson's findings in the direction of ultra-fast circuitry. They still aren't interested in developing fabrication techniques that someday may enable these circuits to be mass produced. But IBM scientists appreciated the implications of Josephson's work and they have come a long way toward translating it into workable electronic devices.

* * *

Some of our scientists are interested in basic knowledge. They want to understand why certain things happen as they do. Others are interested in applied research or advanced projects. They want to build new devices. And, of course, some are interested in both science and advanced projects. But the point is that both kinds of people work together in the Research Division, and there's considerable cross-pollination of ideas as a result.

### On technology as a stimulus to science

Sometimes science influences the course of technology. But, just as often, the problems one encounters in technology give a stimulus and direction to science. This has been historically true, although it is frequently forgotten or overlooked.

* * *

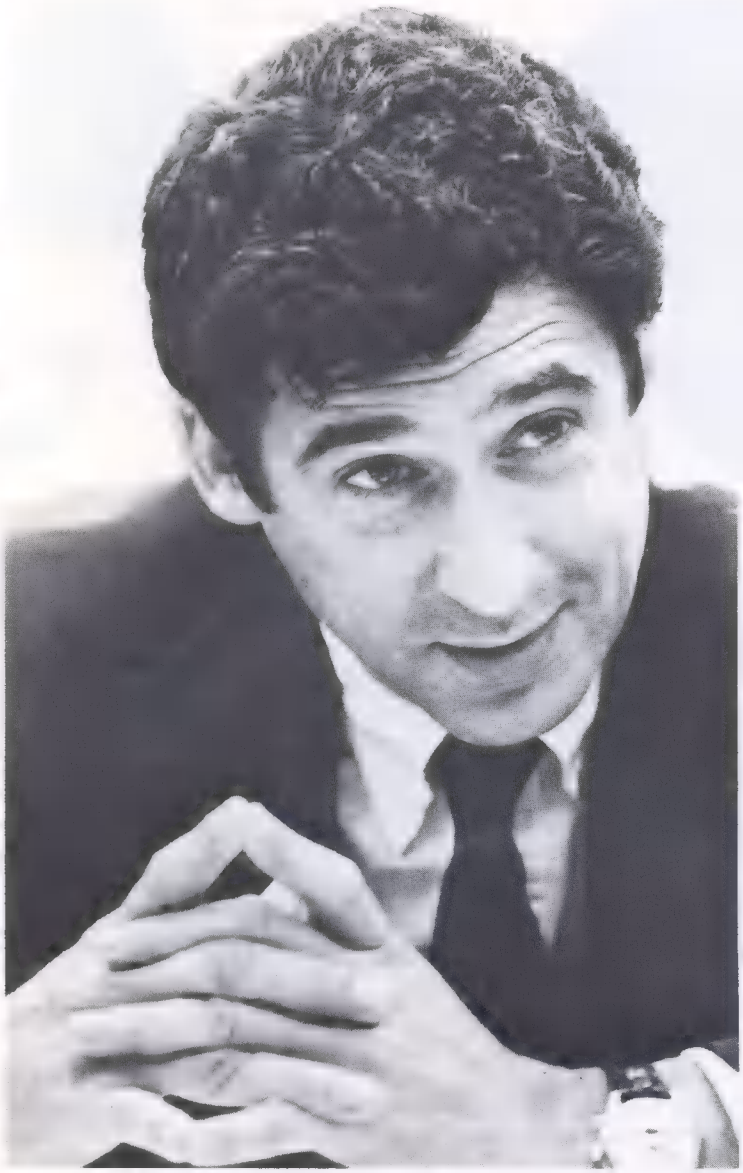
The steam engine was the great productivity engine of the Nineteenth Century, just as the computer is of the Twentieth. Each greatly improved our ability to increase our output in relation to our input. That's what productivity is all about. But the scientific relationship goes deeper than that.

One of the interesting things about the steam engine is that, during the early days of its development, it stimulated scientists to study a new class of problems. In trying to improve its operating efficiency, they discovered the principles of thermodynamics. So, in that sense, the development of the steam engine gave an impetus to science it didn't have before.

We can say the same thing about computer technology, which is still in its early development stage. The work of Shmuel Winograd (an IBM Fellow) is a good example. To improve the operating efficiency of the computer, he has been exploring in a fundamental way the limits on the speed of addition and multiplication and other data processing opertions. His work, and the work of some others, has opened a new field of mathematics that probably wouldn't exist if it weren't for the computer.

* * *

I have great admiration for the contribution people make through the improvement of existing products and the application of common sense. For a long time, that was the only engine of human progress. It still is a major engine of progress today. But the use of advanced scientific knowledge to push things forward is also



a major engine of progress, and, in my opinion, an underutilized one at that.

### On the scientific 'breakthrough'

Too many people regard technical progress as a series of breakthroughs associated with famous names. This is basically a misconception. One idea is seldom enough to establish a new technology. A new technology becomes feasible only after many intelligent people work with great ingenuity to solve numerous technical problems over a long period of time. It's only after you put together all their discoveries and all their inventions that you finally come up with something worthwhile. Then, when it's all over, people look back and say: "That's the electric light. That was invented by Edison." Well, strictly speaking, that's not true. Invention is rarely the work of one person. It takes one discovery on top of another to really bring about a new technology. That's why in-place technology is so hard to displace. You can't displace it with just one idea.

* * *

Science is cumulative knowledge. That's one of the main differences between science and art. Scientists are much more dependent than artists on the work of their predecessors and peers.

### On creating the right environment

One of the most important things in Research is to get the best people even if they don't fit into the project. It's very easy to fall into the trap, especially if you have an exciting project, of hiring people because you need them to do the work. We don't do that. We try to hire the very best people. That's the main goal. Then we worry about the projects. And we try to give them all the administrative support we can. Without imaginative administrative people who have a real desire to get things done, our program could easily become mired down and ineffective.

* * *

Scientific research is difficult, extremely difficult. It's the one field I know where a bright individual can work with great dedication and still produce nothing worthwhile. It happens. But we try to minimize that risk. We try to create an environment that places a high value on individual contribution. If you have good people and expose them to real problems and give them sufficient freedom, then something is bound to happen.

### On the 'practical' nature of science

It's hard to tell where scientific work will lead. The laser is a perfect example of what I mean. The laser has become a standard research tool. It helps us measure the behavior of atoms and molecules. That is only one unforeseen benefit. In recent years, IBM scientists have made many contributions to laser technology, including the development of a tunable laser. Such a laser is tunable in much the same way a radio is tunable. That is, we can select the frequency we want for the application we want. It turns out that the tunable laser may be used to separate fissionable from nonfissionable uranium isotopes for fuel in nuclear reactors. The current separation technology is very expensive. The tunable laser would be much cheaper. Such a technology is a long way from realization. But progress often depends upon these kinds of completely unexpected connections.

* * *

People sometimes ask me if our division will produce a Copernicus or Galileo who will come up with insights that will reshape our perception of the world. They seem to feel that such things couldn't happen in industrial research where we focus on practical things. What they overlook is that great scientists have often been very practical people trying to answer the more pressing problems of their times. Copernicus was trying to devise a reliable calendar. Galileo was interested in building a telescope. But when he looked through his telescope at the moon and for the first time saw real mountains and valleys there, it suddenly changed the way people perceived the universe and their relationship to it.

* * *

I keep a Chinese proverb in mind. It says: "Prediction is extremely difficult, especially of the future." ■

# Corporate Awards

Three new IBM Fellows. And for the four biggest winners, a total of $90,000. 'Wow, what happened?'

by Geoffrey D. Austrian

"You think about the years, the frustrations, the many times you tried things and they failed. But sometimes it comes out right."

The thoughts were Dan Darwin's. And it was the morning after the Corporate Recognition Banquet. The night before, the 56-year-old Boca Raton engineer had become "just a wee bit suspicious" when, after threading his way between the rose-bedecked tables in the ballroom of New York's Waldorf-Astoria Hotel, he found himself seated next to his division president, Jack Rogers, of the General Systems Division.

Four tables to the left, Charles Bleau, a 42-year-old Office Products Division advisory engineer from Lexington, also had an inkling that "something might be in the wind." The kids had come down with colds and he had tried to cancel the trip. There had been phone calls, insistent urgings. But then, "With so many award winners in the room, everyone figures they have a crack at the big ones. When you hear your name, it comes as a surprise."

When a spotlight enveloped table 8, Walt Cralle, a tall, 52-year-old OPD senior engineer from Boulder, realized that "something was up. But I just didn't accept the possibility of it being for me. When Mr. Cary handed me the check, it finally dawned."

The banquet was over, and Bob Pattison, 51, recording component engineering manager from the General Products Division laboratory at San Jose, was up in his room. As he unwrapped his award, a handsome rounded cube of Steuben crystal, he thought, "Wow, what happened?" Before that, it had been unreal.

All four had been singled out for special recognition from among Corporate Award Winners. And for their accomplishments *(see page 38)*, they shared $90,000 in prize money. The banquet, a capstone of a two and a half day recognition event in April, also honored 157 recipients of IBM Outstanding Invention and IBM Outstanding Contribution Awards from throughout the company, and their spouses. Another high point: the appointment of three new IBM Fellows, including the youngest since the program was started in 1963.

Said Chairman Frank T. Cary to

*(Continued on page 40)*

# IBM Fellows

"Vin Learson called me one day and asked me whether I'd ever heard of Andrew Heller," recounts IBM Vice President Dr. Jack Bertram, former ASDD president and now SPD vice president, development and manufacturing.

"He said, 'He's in my office now and about to leave IBM for another job.

" 'Why don't you see if you can keep him in the business,' " the former IBM Chairman remarked.

The year was 1968. And Heller, who had joined IBM two years before, after taking graduate courses in math and physics at Columbia, didn't feel sufficiently challenged despite assignments entailing considerable responsibility for a 20-year-old.

Since that time, Heller, who today reports to the Research Division director of computer sciences at Yorktown Heights, has been pretty well given his head. In the process, he has become known throughout IBM as a consultant, trouble-shooter, innovator, task force member, and catalyst for numerous developments in almost every aspect of computer science. At 27, he is the youngest—by seven years—of any IBM Fellow to receive an appointment.

*Andrew Heller with his wife, Maryann, at Corporate Recognition Banquet.*

With contributions ranging over systems, software, and hardware, it is virtually impossible to quantify Heller's talents. Among his major contributions: improving the recovery and reliability of operating systems, and major innovations in data management and data communications.

Heller, who hides behind a full beard, reveals few details of his personal life. "I give IBM 100 hours a week," he says. "Beyond that, my life is mine."

The "mine" takes in a ranch in Northern California—there are no telephones—and a plane to get him there.

Otherwise, he admits to traveling some 300,000 miles a year for IBM and, according to an associate, "eats, dreams, and breathes computer problems day and night." One secret: He boils along on only two and a half hours sleep out of every 24.

"I have a questioning mind," he comments. "I stick my nose into all the problems I can find. And I intend to keep doing that." □

*Henri Nussbaumer*

*Joseph Pawletko*

Slender, distinguished, and somewhat shy, Henri Nussbaumer, when he isn't scaling an Alp, is almost certainly one of IBM's most prolific inventors.

He doesn't keep exact count. But records reveal that the 43-year-old La Gaude engineer has 44 inventions to his credit. They have resulted in 239 patents in the U.S., France, Germany, Canada, the United Kingdom, Italy, Japan, Switzerland, Austria, the Netherlands, and Belgium.

The French engineer, according to La Gaude Laboratory Director Maurice Papo, has made significant contributions in electroplating, telephone switching, and data transmission since joining IBM in 1957. His most recent advances are in signal processing. He is among the first in IBM to apply signal theory in a practical way, thus helping to develop modems. Modems, or signal devices, developed mainly at La Gaude and Raleigh, use conventional telephone channels to transmit data.

Despite a reticent manner, Nussbaumer is known as an aggressive manager who wins respect for judgments that have a way of turning out to be right. As a program manager, he launched the development effort that resulted in the 2750 and 3750 voice and data switching systems. These products, successfully marketed in Europe, apply computer techniques to telephone switching.

More recently, he reactivated the La Gaude Advanced Technology Group and helped create a healthy ferment of ideas and people that has led to further advances in communications. His title is manager of education and technical vitality at La Gaude.

When he talks about himself, he generally calls himself a "generalist." But those who know him consider him an engineer—with a Capital E—in the broadest sense of the word. They also reserve for him the highest accolade for one in his profession: "What he invents, works." □

"I have a nice collection of roses," confides Joseph P. Pawletko. "Making them grow is so relaxing that I get many solutions to problems just trimming and weeding my garden."

At 48, Pawletko, a senior engineer at the System Development Division Endicott laboratory, provides convincing proof that creativity is not limited to the young . . . "You have to be fascinated by new things," says the engineer, whose interests extend to sailing and a compendious collection of classical and popular recordings. Bach and Mozart are favorites.

Pawletko's talents surfaced early. As a youngster, he built and sailed radio-controlled boats on a lake near Chorzow in his native Poland. When World War II broke out, he escaped to Italy at 18, joined the British Army, and became an instructor in an army communications school. He worked in a laboratory in Britain, then came to the U.S., where he won a scholarship to Stevens Institute of Technology.

He joined IBM at Endicott in 1955. "I chose IBM because they had started in computers." His first major contribution was doubling the density of the drum memory of the IBM 650 computer and devising logic that enabled the system to employ the large capacity memory with existing circuitry.

The main forte of the engineer, who has received 15 patents and two Outstanding Contribution Awards, is developing and perfecting stepper motors, devices that start and stop very quickly and accurately. In their design, he has shown an unusual talent for moving ideas rapidly from concept to practical devices. His inventions have quickly found their way into numerous IBM products.

Does the electromechanical technology in which he specializes have a future in this electronic era? "It has not flattened out. It still has a growing potential." As might also be said of Joseph Pawletko's inventive talents. ■

# Jumping

In long-ago 1959, when the world still had time for nonsense, the distinguished photographer Philippe Halsman published an amusing little volume called the *Jump Book*. In it, photos of some of the world's most accomplished people—jumping. Among them: Judge Learned Hand, Adlai Stevenson, Dr. Robert Oppenheimer, captains of business and industry. Why jumping? "Because," says Halsman, "when we look at someone's face, we don't know what he feels. But in the sudden energy of a jump, the real self becomes visible."

To find this real self—or maybe just because it's Spring—we asked this year's four top Corporate Award Winners to jump for joy and for the camera.

©1959 by Philippe Halsman

**Walter O. Cralle, Jr.,** who split $40,000 with Charles D. Bleau, came up with the initial idea for a single sheet document feed for Copier II. Cralle, an OPD Boulder senior engineer, also provided throughput studies that helped gain acceptance for the feature called the semiautomatic document feed. As a result of the feed, the useful speed of Copier II is increased without speeding up the product's internal process speed.

**Charles D. Bleau,** who received half of a $40,000 award as co-developer of the semiautomatic document feed, shouldered much of the detailed design work. The OPD Lexington advisory engineer came up with a simple reliable design for a belt feed that feeds and aligns documents to be copied. The work of Cralle and Bleau gives Copier II distinct paper-handling advantages.

**Robert E. Pattison,** winner of $30,000, pulled the company out of a near-disastrous situation after personnel losses and technical difficulties nearly crippled the 3330 development program at San Jose in 1967. The GPD engineering manager led the way in meeting all schedules and exceeding all technical objectives for a product family whose economic success has exceeded expectations.

**Daniel P. Darwin,** winner of $20,000, stuck to his guns for 18 months before anyone would make his low-cost, high-speed printer part of a program headed toward announcement. The General Systems Division Boca Raton engineer's invention prints forward or backward—and is quieter than a typewriter. Today, it is either marketed with or incorporated in four announced products, including System/32.

*(Continued from page 36)*

the gathering: "Each of your awards reflects a significant effort. Taken together, I can only say they have a tremendously important effect in keeping the IBM company moving forward."

At the banquet, Cary recognized two IBM Fellows who would soon be retiring. Both from Poughkeepsie, they are:

- Steve Dunwell, who led the development of the pioneering STRETCH computer. "From a man with that kind of innovation," said Cary, "we can only expect many more trails blazed in the years ahead."
- And Walt Buslik, who had made major contributions to tape drive and disk technology—"contributions essential to IBM leadership in the world of random access devices."

It was a gala occasion. As IBM Vice President and Chief Scientist Dr. Lewis M. Branscomb put it, "a really prodigious confirmation of the talent and human resources at the heart of IBM's success." Co-host with Dr. Branscomb for the recognition event was Jerrier A. Haddad, IBM vice president, engineering, programming and technology.

"More people were recognized this year than ever before," said Haddad, "indicating the kinds of people we have in IBM. This is a happy portent for our future."

Other speakers at the event included Jack Rogers—nearly continuous demonstrations of GSD's recently announced System/32 were an attention-absorbing diversion—and Ralph A. Pfeiffer, Jr., IBM senior vice president and chairman of the IBM Americas/Far East Corporation. Dr. Dixy Lee Ray, Assistant Secretary of State for Oceans and International Environment and Scientific Affairs, spoke at the closing luncheon.

This year's IBM Fellows, appointed for five-year terms in recognition of distinguished and sustained technical achievement in science, engineering, programming, and systems, are an especially diverse and talented group. ■

# NEWEST

## With IBM's 6:5 Cartridge System, dictation will never be the same

"Take notes," the teachers said, and most of us have been doing just that ever since. The executive, the engineer, the physician—people in every conceivable occupation—learned the lesson well and devote a considerable amount of time to "jotting it down."

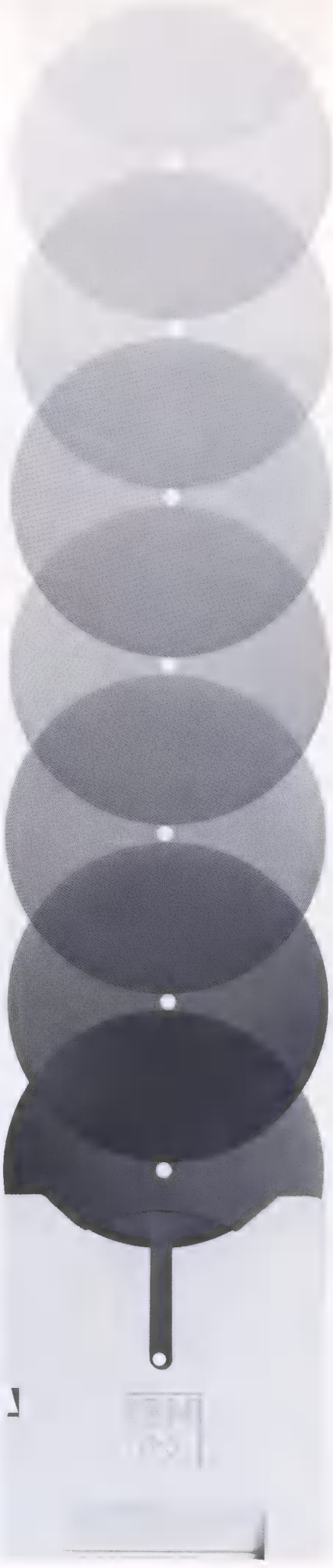
Now the Office Products Division has taken careful aim at that time-consuming habit with its newest product, the 6:5 family of input processing equipment (IPE). OPD President Bart Stevens calls it exactly the right product to meet the needs of the day. Since announcement this spring, sales of the IBM 6:5 Cartridge System have soared well above expectations.

OPD's planners and engineers zeroed in on everyone's affinity for pen and pencil when IBM entered the dictation equipment field fifteen years ago. "The business environment that existed then is changing drastically," says Al Winegar, OPD director of marketing plans. "We knew that we would have to come up with a totally new approach to dictation in order to help solve the complex problems our customers would face in the late 1970s."

Introduced into an industry crowded with loops, tapes, and cassettes, the 6:5 uses small (three and one-quarter inches in diameter) magnetic discs packed 25 to a cartridge. The product name represents the six minutes' recording time on each disc and the five hours' recording time on each machine.

The approach is unique. As OPD explains in its advertising campaign—the most extensive in the history of the division—the 6:5 recording medium offers the convenience and accessibility of belts plus the long recording capability of tapes.

Equally important, according to Jack Sprague, product manager for the division's line of input processing equipment, is the modular concept of the IBM 6:5 Cartridge System. "For the first time, a customer will be able to



add—not replace—equipment as his needs grow," says Sprague.

OPD's new dictation system is built around the 6:5 recorder. With the addition of appropriate control boxes, that recorder grows from a desk-top unit into a remote microphone system, a Touch-Tone® or dial telephone system, or a message system. A cartridge holds up to 25 discs. Each disc holds up to 6 minutes of recording time, or 2½ hours of recording time per cartridge. The recorder holds two full cartridges of discs for a total of 5 hours of recording time.

Dictation can be easily segmented—a rush job put on one disc and expedited, while other less critical dictation continues on other discs—no small feature in today's productivity-conscious business climate.

"We believe the 6:5 represents the best of all worlds," says Ernie Pope, manager of IPE marketing programs, "and our customers seem to agree."

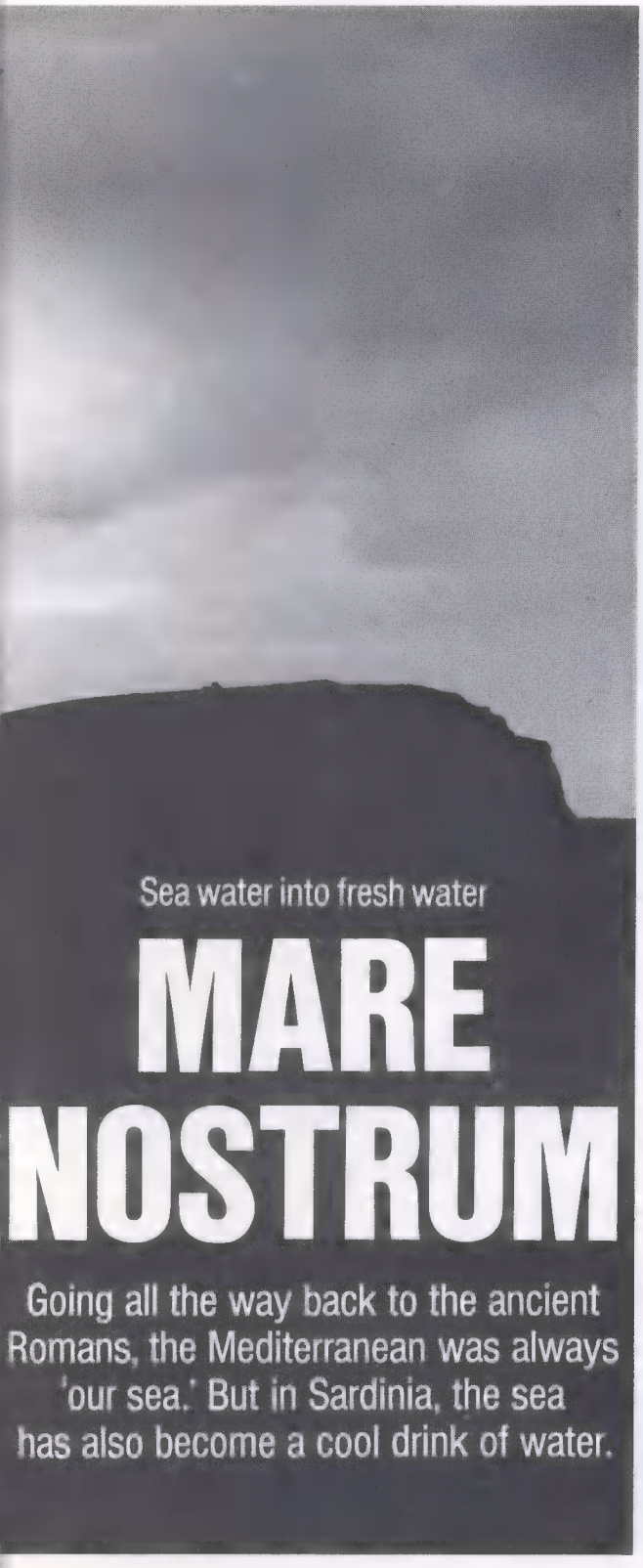
In March, with only eight selling days left after announcement, nationwide sales topped 140 percent of monthly quota. April results also exceeded expectations, with the long-range outlook bright.

In New York's Broadway office, Branch Manager Ed Combs says the 6:5 has been enthusiastically received by banks with 200 or more branches and by small institutions as well.

Marketing Rep Jim Elliot in Butte, Mont., says the message system feature of the 6:5 sold it to two hospitals where physicians wanted a 24-hour call-in dictation service.

According to Bill Fuhs, marketing rep in the Philadelphia Midtown office, the work load distribution possibilities of the 6:5, combined with its long recording capability, helped him close a large sale to a customer converting to a word processing installation.

Those successes are being repeated in branch offices around the country. ■



Sea water into fresh water

# MARE NOSTRUM

**Going all the way back to the ancient Romans, the Mediterranean was always 'our sea.' But in Sardinia, the sea has also become a cool drink of water.**

Sardinia's hot and dry climate is relieved by only a few rainy months in winter. The rest of the time, some parts of the Mediterranean island resemble other arid areas of the globe. Little stirs. Life has crawled along at the same sluggish pace through the centuries.

Which is one reason why Sardinia has long been known as *l'isola dimenticata,* or "the forgotten island."

The other reason has been the mysterious *mala aera*—the bad air—or malaria, as it has come to be called, that has hung over the island like a funereal pall. Through the ages, political prisoners were dumped on the island to become enfeebled by the "Sard disease." Few escaped. And Sardinia was avoided despite its potential riches.

The malaria scourge was licked following World War II when thousands of Sards, armed with spray guns, sprayed virtually every inch of their 9,300-square-mile island. Every human and animal habitation was sprayed—from shepherds' huts to medieval churches to dank stone ruins of early Romans and Phoenicians. Swamps, ponds, and irrigation canals were cleared of larvae of the malaria-carrying Anopheles Mosquito, and sprayed. By 1953, the all-out battle—funded largely by the Marshall Plan and directed by Rockefeller Fund public health technicians—had succeeded. Malaria was eliminated.

But the water problem remained. And Sards, looking out to sea, could draw little comfort that 97.2 percent of the world's water is in the oceans. Or that scientists have been struggling to come up with economic methods of desalination ever since Aristotle advised Greek sailors how to evaporate fresh water from salt in the Fourth Century B.C.

*Starved for water though surrounded by it—that seemed Sardinia's fate. Now pipes running a quarter-mile out to sea bring in salt water for processing at one of the world's largest desalination plants.*

Plans for solving the island's critical water problem were set in motion when Societa' Italiana Resine, a multifaceted chemical corporation, placed a $480-million petrochemical complex on stream in 1968. At first, water was piped in from nearby lakes. But a great deal more was needed if the company was to keep pace with its planned growth for the Seventies.

Rather than wait for a long-discussed regional waterways project to take shape, "we decided to go ahead on our own by bringing in water directly from the sea alongside the refinery," says Luigi Ciabatti, manager of the company's Porto Torres plant. "That is, to build our own desalination plant to meet all our needs—present and future—and also to serve as a kind of pilot project for people everywhere wishing to get fresh water from the sea."

The first steps were taken—not in Sardinia—but at the corporation's Project Optimization Center in a Roman suburb. And the steps were made within an IBM computer. By programming technical parameters into the computer and testing chemical processes against hoped-for results, engineers gradually built an optimal model of the plant.

Today, the actual plant—one of the largest desalination plants in the world—rises just beyond Porto Torres, a once sleepy coastal town. And going there can be a mind-boggling experience. The brand-new highway skirts the sea, overlooking bare, water-logged land on the other side. Stone fences, clumps of scrub brush, and olive trees straggle on to the horizon.

Suddenly, the Twentieth Century confronts the Sixteenth as marshes give way to a breath-taking complex of smokestacks, towers, squat storage tanks, and giant grasshopper-shaped derricks. Out of the vast latticework of pipes and tubes, the refinery comes into view along with a cluster of other plants. The entire desalination plant is controlled by a crew of 10 people—and an IBM computer.

Water is sucked into the plant

*Above: Luigi Ciabatti, manager of the desalination plant at Porto Torres, views his facility as "a kind of pilot project for people everywhere wishing to get fresh water from the sea."*

*Left: One of a crew of 10 at the plant, a technician checks readings on an instrument panel. Measurements are taken at 33 different stages in the desalination process. From them, an* IBM *1800 computer sends out signals adjusting flow-rates.*

*Right: Testing time. Final traces of salt are removed through condensation. The Porto Torres plant can produce up to 700 tons of pure water per hour.*

*Below: On Sardinia's industrial horizon since 1968, the petrochemical complex of Societa' Italiana Resine. The company's desalination plant first took shape as a model in an* IBM *computer.*

through pipes running a quarter-mile out to sea. There it goes through a number of processes until it arrives at a de-aerator which removes oxygen which would otherwise corrode the pipes. Finally, the water reaches long chambers where it is heated to 230 degrees Fahrenheit, and vaporized. Condensation removes any remnants of salt that remain. The process is repeated several times.

Inside a small, squat, white, single-storied building is an IBM 1800 computer which controls the process every step of the way. "We take readings at 33 different stages," says Antonio di Maio, a chemical engineer, who serves as technical director. "We measure temperature, pressure, water level, amount of brine, acidity, flow-rate—a total of 400 parameters—at each stage.

"From these readings, the computer sends out signals that adjust the flow-rates. All this allows us to vary and control every step of the process for the most efficient plant operation."

He steps over to a printer and glances down. "Production at the moment is 480 tons an hour. We can reach a maximum of 700 tons. In winter, we don't need that much because of the rains. This summer, both lines will be in full production."

How pure is the water? "It is very, very pure," asserts the director. "From sea water that contains about 70 thousand parts-per-million milligrams (PPM's) of salt in a liter of water, we get down to from 1.0 to 1.5 PPM's."

Near the computer room is a scale model of a pilot plant under construction for the Government of Bahrain on the Persian Gulf. Three Bahrain engineers hover over the model which is similar to the parent plant—but adapted to the region for which it is destined. They are studying the parent plant and learning to run the pilot for their own country.

Several other Middle Eastern countries have placed orders for similar desalination plants, inspired in part by the changes already springing forth in Sardinia. New jobs and social changes are already evident in the Porto Torres area. The petrochemical plant capacity is expected to double before 1980 —which should result in many more jobs; many more people being able to raise their sights and afford a better way of living.

Long before 1980, a much-discussed joint Societa' Italiana Resine-Sardinian Regional Government waterways project is expected to get under way. It means that local farmers will have use of excess fresh water from the plant, and more fertilizer.

Moreover, through a joint-venture subsidiary, Siron, the corporation is now building a factory in the mountains around Nuoro, in what was once considered "bandit country." Using Porto Torres chemicals, it will produce synthetic fibers and synthetic leather. The plant is expected to employ some 5,000 additional local citizens.

Finally, newer, secondary industries have sprung up, using various Porto Torres-produced materials, and set up by the corporation in several joint-venture operations. These can be seen, especially in the south and central parts of the island, which are being peppered with bright new plants and plotted with the foundations for entire industrial parks—where only wheatfields surrounded by cactus fences and remote valleys were before.

The socio-economic spin-off is also affecting other regions of Italy's southland and beginning to be felt in outlying parts of the developing world. Sardinia is pulsing with new life. A few years from now, it will no longer be known as the forgotten island. ■

by Claire Stegmann

Tom Ryder, a Salt Lake City businessman, picks up his weekly payroll at a computer service bureau. He stops for a Coke. Then it's back to his office in his Citroën for an appointment with an IBM salesman. He's considering a computer of his own; and he'd like to have it by the time his son, just graduating from M.I.T., joins the firm.

Ryder might be surprised to learn that everything he has just done is involved, in some way, with the computer time-sharing language, APL.

- The customer service bureau he uses, which offers APL service, is operated by Management Systems Corporation, a wholly owned subsidiary of the Church of Jesus Christ of Latter-day Saints. The Mormon Church, as it is more commonly known, also uses APL in many of its own operations.
- Both The Coca-Cola Company and Citroën are increasing users of APL.
- The IBM salesman, to help Ryder tailor a computer to his particular needs, will almost certainly consult a terminal in his branch office for design analysis and to find out what IBM products and services are available, and where. That terminal is tied into the Data Processing Division's HONE (Hands-on Network) system, which makes significant use of APL.
- If Ryder decides to order, the System Products Division's worldwide commodity planning system, based on APL, will enable SPD to provide the earliest possible delivery date.

Incidentally, Ryder's son, back at M.I.T., uses APL to do his homework. And he and his father share another APL-based activity: the National Football League statistics they follow so closely are compiled with the language.

Ryder and his son are fictitious. But the APL applications are real. They illustrate the versatility of *A Programming Language*, which has come into its own as an important product for the computer user.

For most of its 13 years, APL's primary habitat has been the classroom, where, as an extension of simple mathematical notation, it has helped high school and college students learn not only algebra, but also economics and electrical engineering. In Atlanta, students use it to design and compute the cost of making cabinets.

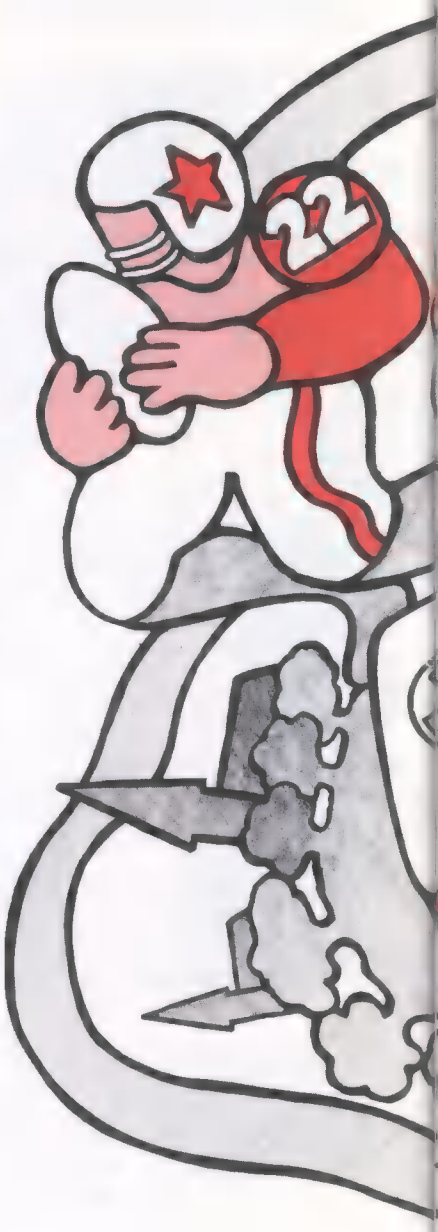
IBM Fellow Dr. Kenneth Iverson, who invented APL as a precise way to describe data processing, explains: "Every field of human knowledge that deals in quantity—mathematics, physics, economics—has a special vocabulary that must be put into a general-purpose language for computer use. APL defines these terms by their simple mathematical formulas, using a number of symbols, some of them (for example, $+$, $-$, $\times$, $\div$) already familiar to every school child. Thus, as a student learns APL, he or she is also reinforcing knowledge of a particular discipline."

Dr. Iverson believes that APL's versatility as a teaching aid has barely been touched. Much of his work as a Fellow is devoted to helping educators in many fields study its application to their particular specialties.

But, according to Dr. Truman Hunter, APL manager, because APL is relatively simple to learn, versatile, and interactive (the user and the computer "converse" during the processing of a job), it is becoming more and more attractive to business for management decisions that need frequent updating and quick response.

"This has been especially true," says Adin Falkoff, Dr. Iverson's longtime collaborator, "since the introduction of an APL program product called the APL Shared Variable System. This makes it efficient and convenient to work with files and data bases." Both APLSV and APL/CMS (Conversational Monitor System), recently introduced by IBM, enable the APL user to do a greater variety of jobs on a much larger scale than before.

"It is the analytic power of APL, the language," says Dr. Hunter, "plus the easy access to large stores of information, that I think is going to make it increasingly important to the businessman. Now, more than ever, he can




THINGS GO BETT

develop applications and get results while they are still timely."

APL and its conversational cousin BASIC are by far the most widely used languages specifically designed for terminal use, which allows the user to bypass such time-consuming steps as going to, and queuing up in the computer room. Of the two, BASIC is older and more widespread. But, according to Curt Bury, DPD senior product administrator, APL's inherent power is extending its effectiveness to areas beyond the scope of BASIC. An IBM operations planner agrees: "We planners have to sort out a great many complex relationships in a very short time. APL is the only game in town for this kind of thing."

IBM's accelerated use of APL since it was first introduced in the mid-Sixties, on the IBM 1130 and System/360 Model 40 and above, reflects the recognition of the language by data processing people as an effective way of getting applications written faster. "In the past several years," Data Processing Division President John F. Akers told a GUIDE user-group last year, "we have gone from 4,000 to 16,000 APL users within IBM. And the balance has shifted from scientific to commercial users."

Every IBM division relies on the language in some way. DPD's HONE system, which connects U.S. branch offices to a central data base and makes heavy use of APL programs, made a tremendous contribution to field productivity. In what is possibly the largest single use of APL, SPD's commodity planning system integrates production schedules so efficiently that decisions that used to take two months can now be made within a matter of minutes. The General Products Division depends on APL to write test cases for its new 3850 mass storage system. Many aspects of the business of IBM in Europe, according to Yves Le Borgne, advisory APL support representative in Europe, are managed from APL terminals. IBM World Trade Americas/Far East Corporation has used APL to develop applications for both its oper-

# ER WITH APL

ating plans and its strategic planning.

Office Products Division engineers use APL in the development of Copiers and magnetic keyboard typewriters. OPD, incidentally, has another interest in the language. It makes the APL Selectric typing element.

In a move that brought APL into the mainstream of IBM software production, the APL group was transferred last year from DPD's Philadelphia Scientific Center into SDD. A design group, consisting of Iverson, Falkoff, Richard Lathwell, and a small staff, remain in Philadelphia. The implementation group, under L. A. Morrow, joined the SDD programming center at San Jose. "We consider APL one of the primary interactive environments for current and future systems," says R. E. Ruthrauff, SDD manager of language and data facilities advanced system design.

One strong advocate of interactive computing, and of APL in particular, is Professor Ephraim McLean of U.C.L.A.'s Graduate School of Management. He introduced APL to the business school four years ago. Today, it is a requirement for all entering M.B.A. students.

This summer, with an IBM grant, Professor McLean will offer a course on interactive computing to a limited number of faculty members from other business schools. "I have been surprised at both the number and the variety of requests for applications," he comments. "They come from all over —a Jesuit priest, a woman marketing professor, a faculty member from Howard University, several individuals from both French and Mexican universities, and a surprisingly large number of business school deans and department chairmen."

Next, McLean hopes to do a study on the increased effectiveness of APL users. "I think a study will find that APL is much more productive," he says. "For instance, I am convinced that with APL a programmer can accomplish in 10 instructions and a few hours what might take 200 instructions and several days in COBOL or FORTRAN."

One of the beauties of APL, says Dr. Iverson, "is that you have to learn so little to get started, like a child, or a grownup for that matter, learning a language. You tell a child two or three things and he builds his vocabulary gradually. With APL, you gradually accumulate a knowledge of the symbols as you do more and more work."

Several clerks and secretaries in town halls near Paris would probably agree. They have never seen a computer but are using terminals, and APL, to do payrolls they formerly did by hand. "Here in Europe," says Yves Le Borgne, "we are confident that APL has a great deal to offer our customers —especially now, with the economic crisis, when there is a need for better management to grasp a situation and react to a changing environment quickly."

In May, Iverson receives the annual Harry H. Goode Memorial Award from the American Federation of Information Processing Societies, for the impact APL is expected to have on programming language theory and practice in the future. The setting would be the envy of many youngsters: Disneyland, in California. But it probably wouldn't impress the son and daughter, both under nine, of IBM senior programmer Corey Fair in East Fishkill. Since the Outstanding Contribution Award winner (for his part in development of the SPD commodity planning system) brought a terminal home, his kids don't watch Walt Disney on TV much anymore. Instead, they compete for time on the terminal, when allowed, to practice APL. ■

## Here's how it works

One of the virtues of APL is that it is interactive, that is, a person can "converse" with the computer during the processing of a job. Here is a simple example of how such a conversation might go:

Let's say a businessman wants to examine the feasibility of taking out an $8,000 loan at 9½ percent interest. He wants to see what his monthly payment would be each month if he repaid the loan over an eight-year period. Also, for income tax purposes, he'd like to know what his annual interest would amount to each year.

Now, let's assume that the APL program to perform this function is identified in the computer as ME. The businessman begins by typing:

M E

The computer responds:

*ENTER PRINCIPAL, ANNUAL INTEREST (AS A DECIMAL), AND NO. OF YEARS*

The businessman types:

8 0 0 0 . 0 9 5 8

The computer comes back:

*ENTER MONTH AND YEAR THAT FIRST PAYMENT IS DUE (E.G. 8 73 FOR AUG, 1973)*

The businessman types:

5 7 5

The computer prints out:

*PAYMENT AMOUNT IS* 119.29

| *END OF YEAR* | *ANNUAL INT.* | *PRINCIPAL REMAINING* | *END OF YEAR* | *ANNUAL INT.* | *PRINCIPAL REMAINING* |
|---|---|---|---|---|---|
| 1975 | 494.05 | 7539.73 | 1980 | 340.52 | 2984.95 |
| 1976 | 684.30 | 6792.55 | 1981 | 232.24 | 1785.71 |
| 1977 | 610.15 | 5971.22 | 1982 | 113.23 | 467.46 |
| 1978 | 528.63 | 5068.37 | 1983 | 9.28 | .00 |
| 1979 | 439.02 | 4075.91 | | | |

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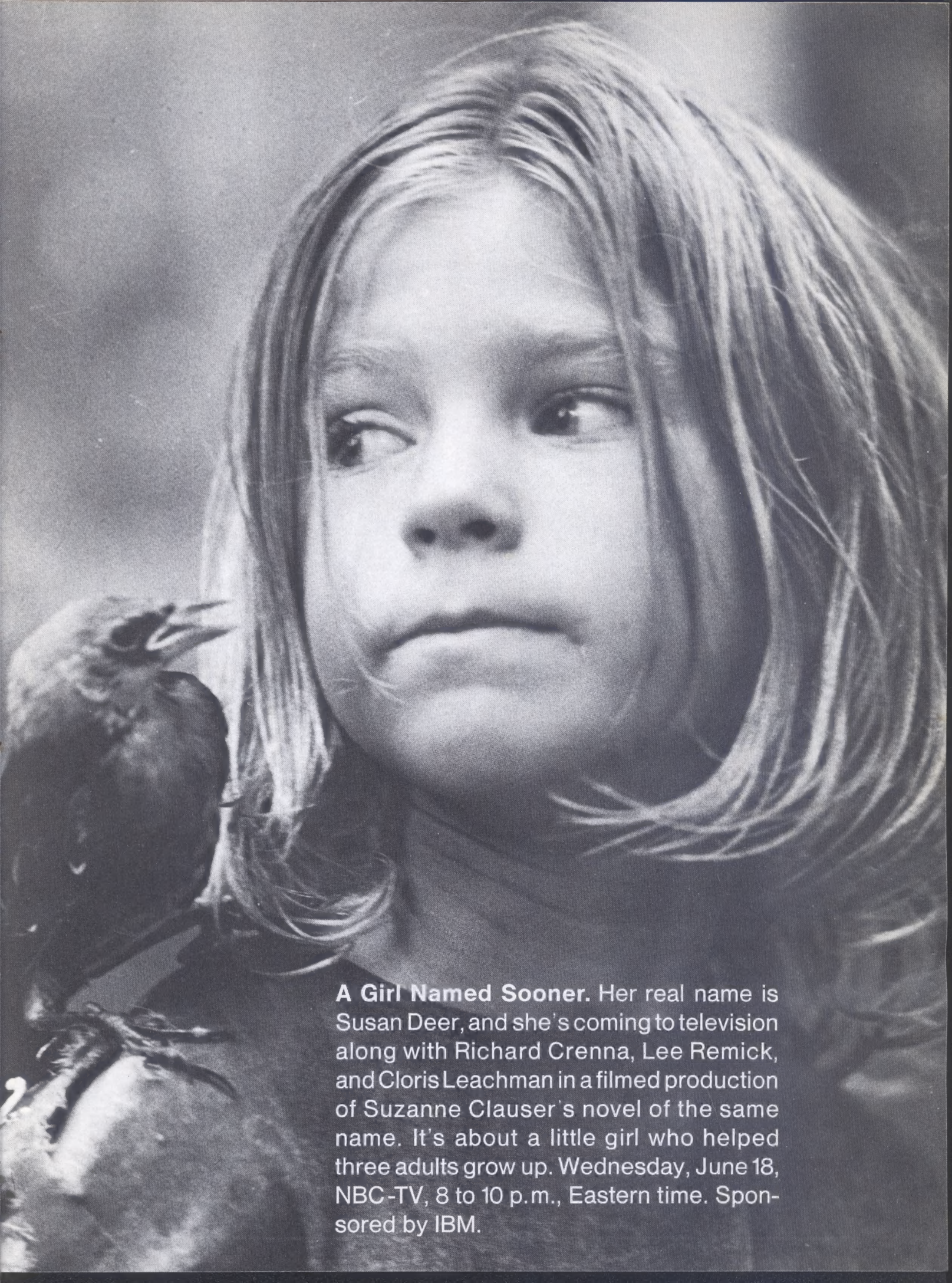

**A Girl Named Sooner.** Her real name is Susan Deer, and she's coming to television along with Richard Crenna, Lee Remick, and Cloris Leachman in a filmed production of Suzanne Clauser's novel of the same name. It's about a little girl who helped three adults grow up. Wednesday, June 18, NBC-TV, 8 to 10 p.m., Eastern time. Sponsored by IBM.

## Who stands for the corporation?

No one, says Irving Kristol. And that's one of the reasons business can find itself in a squeeze. With no constituency to speak up for it, the corporation is hard-pressed in the conflict of interests and ideas that is so much a part of the American system.
Page 8

## 'Ich bin ein Berliner'

So said President Kennedy in 1963 to 150,000 cheering Berliners. Today, Berlin is a changed city in the middle of a changed world. And home to some 1,500 IBM people. It is also the site of one of the company's newest Office Products plants.
Page 14

## Things go better with APL

How an easy-to-learn programming language is helping increasing numbers of businessmen keep on top of change.
Page 46

## How to cut costs

With profits down almost everywhere in American industry, the squeeze is on to cut costs. So, too, in IBM.
Page 4

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